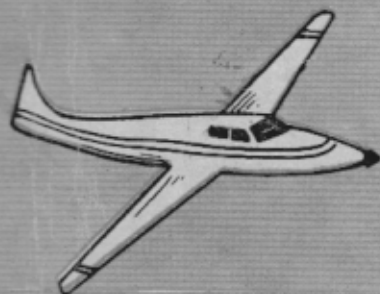


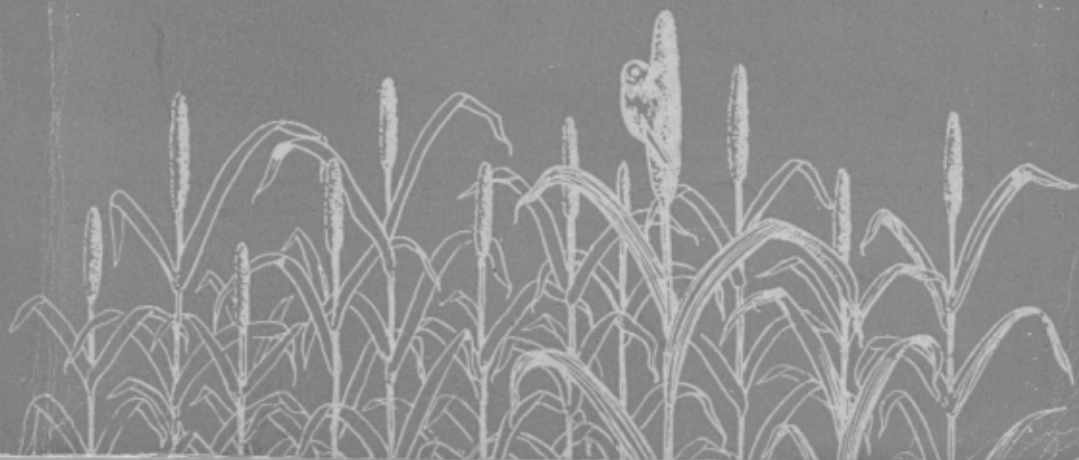
MANAGEMENT OF

PROBLEM BIRDS

IN AVIATION AND AGRICULTURE



R.A. AGARWAL
R.K. BHATNAGAR



*With best compliments
R. Bhatnagar*

PROCEEDINGS

SEMINAR ON MANAGEMENT OF PROBLEM BIRDS IN AVIATION AND AGRICULTURE

(May, 25 and 26, 1982)

R.A. AGARWAL AND R.K. BHATNAGAR
(Editors)

Sponsored by
AERONAUTICS RESEARCH AND DEVELOPMENT BOARD,
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AND
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NEW DELHI



MESSAGE

AIR CHIEF MARSHAL
DILBAGH SINGH PVSM AVSM VM ADC
CHIEF OF THE AIR STAFF

AIR HEADQUARTERS
NEW DELHI-110011

1. One of the biggest hazards to flight safety, all over the world is the menace posed by birds. In India the magnitude of the problem is much greater due to the species of birds—the vultures and pariah kites, that our aviators have to contend with. In the recent years the Indian Air Force had suffered a phenomenal loss of aircraft and pilots as a result of collision with birds; not to mention the loss of human lives and property on the ground. No country in the world can afford to lose valuable aircraft and invaluable pilot at this rate, much less a developing country like ours. The bird menace in our country has already assumed grave proportions and needs to be tackled on war footing at the national level by all possible means.

2. Today there is a growing awareness of this very real problem by the Govt. and civil agencies. It is indeed heartening therefore to find the Indian Agricultural Research Institute a premiere Institution of the country joining hands so to speak with the aviators in dealing with the problem through the conduct of a seminar on the "Management of Problem Birds in Aviation and Agriculture." Birds naturally congregate where food is readily available. The need of the hour is to deny these birds such large scale open-air catering service. An effective start in this direction would be to ensure cleanliness in and around our airfields and those recognised routes of air operations where aircraft performance have to fly low. Additional ways to reduce and control the bird population all over the country would no doubt have to be considered.

3. I convey my best wishes to the Indian Agricultural Research Institute and sincerely hope the measures that emanate from the seminar as also from all further undertakings directed towards reducing the bird menace, meet with success.

Sd/-
Air Chief Marshal
Chief of the Air Staff

2, November, 1982

PREFACE

India is bestowed with richness and diversity in avian fauna in all the agroclimatic regions. Birds are found at an altitude of 18,000 down to sea level, rain forests and even in arid Thar. In the taxofaunistic terms, we have 1200 species out of 8600 found in the world.

Few smaller birds like the Mountain Quail and the Pink Headed Duck are believed to be extinct and others like the Great Indian Bustard is in danger. Of the various factors attributed by the conservationists threatening the life of aves in India, the fast developmental activities are said to be one of the main cause. Conservationists also attribute these to modern agricultural practices like use of pesticides, extensive monoculture, deforestation for agricultural purposes, urbanisation and the environmental pollution due to large scale industrialisation. At the same time there are problem birds supplemented by problems created by birds to the economic development, eg., losses caused by them to agricultural crops and losses due to Bird Aircraft Strike Hazards (BASH) etc. The latter amounts roughly to an annual expenditure of Rs. 300 million besides losses to human health and public nuisance etc. These aspects on life of aves, ecological imbalance, pollution and safety to human beings etc., are some of the major considerations of their scientific management. The latter need investigations, as the bird management is very complicated in its nature, probably because of multiplicity of economic and population status of our birds.

Some of our threatened avian species are problematic in agriculture. The scavenging birds are major species involved in BASH. Similarly species found in abundance are the common depredatory species eg. the parakeets, the common house sparrow and feral pigeons. The common house sparrow is of immense potential as an insect predator. It deserves management, where as the feral pigeons deserves intensive investigations on its feeding and behaviour patterns etc.

The depredatory activities of birds are known to us for over 500 years. They have, however, drawn little attention. It is because, barring few centres, studies on birds are rather neglected. Recently ARDB and DGCA have shown great interest in birds and have been playing a major role in tackling the bird problem specially in relation to Air Flight and its safety.

Studies on applied ornithology comprises multi-disciplinary approach. The insight of articles will confirm the great need to encourage and create interests in this branch of biological science. Therefore, at the country's first working group meeting on Management of problem Birds in Aviation and Agriculture, efforts were made to plan a 'spring board' for future research and development in India. Therefore, in this seminar scientists conservationists, and eminent scientists and all those interested have assembled to speak on their experiences and also to take stock of the work done by them in India.

Adherence to conventional format of acknowledgements in a preface would be too lengthy to mention. However, success of our endeavour is attributed to the encouragement, collaboration, and support accorded to us by authorities of the Indian Agricultural Research Institute, especially Dr. H.K. Jain, Director, IARI, Shri Vivek R. Sinha, Chief Controller, R and D, Ministry of Defence and his officials in ARDB in particular Air Cmde. S.C. Gupta and Shri K.N. Krishnamoorthy, A.V.M. P.P. Singh and his officials in Directorate of Flight Safety, Dr. B. Venkatraman, Secretary, Ministry of Civil Aviation and his officials in Directorate of Flight Safety in particular Shri H.B. Singh, Capt. Bhasin and Capt. R.P. Barnwal of Indian Airlines and Dr. B.G. Dharne and last, but not the least, to our colleagues in Division of Entomology, Indian Agricultural Research Institute, Indian Council of Agricultural Research and the Nuclear Research Laboratory, we are indeed very grateful to them for their guidance and help. To our colleagues, Late Dr. M.G. Jotwani, Dr. K.P. Srivastava, Dr. D.K. Butani, Shri M. Raizada and Shri G.S. Sharma we owe our heart felt gratitude for their untiring assistance throughout this venture. We regret that due to certain financial limitations we had to cut some articles and some could not be included. To Drs. V.V. Ramamoorthy, A.K. Chakravarthy and Sri Ravi Palta, we are thankful for proof reading. To Dr. Prem Kishore we are grateful for helps in final corrections of the manuscript.

It is hoped that all those concerned with management of Aves would find this book a meaningful document and pace setter for the next production of all the information, generated in future and not quoted in this book.

R.A. Agarwal
R.K. Bhatnagar

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PART - I

Management of Problem Birds
in
Aviation

WELCOME ADDRESS

DR. H.K. JAIN

Air Marshal P.P. Singh, distinguished scientists, administrators and others from large number of different organisations in the country, I would attempt the difficult task of naming some of the participants in the Seminar on Management of problem Birds. We have of course, distinguished I.A.F. officials and scientists from the Ministry of Defence, delegates from Indian Airport, International Airport Authority of India, especially the Chief of the Operational Problem Group and his Officials, Director of Air Flight Safety, Wild Life Authority, Bombay Natural History Society, representatives from the Ministry of Tourism and Civil Aviation and then especially we have the privilege of having Dr. Venkataraman, Secretary, Ministry of Civil Aviation who is personally present with us this morning. We have also representatives from Department of Environment, Zoological Survey of India and Directorate of Operations, Indian Air Lines. We have representatives of the Bone Industry, Pesticide Industry and the group which constitute the Airfield Environment Management Committee, Delhi Development Authority, Directorate of Plant Protection of the Govt. of India, Directorate of Conservancy, Sanitation and Engineering of Municipal Corporation of Delhi. In addition to all this, we have Senior Official from Space Application Centre. Last but not the least, we have Directors and representatives from various concerned Directorates of Civil Departments, in addition to this, we have many Zoologists, Entomologists and Ornithologists.

Birds are many splendoured things, because this alone from my view can justify and explain such wide participation. Once again, I want to say how happy I am and how pleased my colleagues are that all of you accepted our invitation to be with us here this morning. I think it

is one message which your presence here indicates and which is that as some people may think birds are not an unmitigated menace. I think it is better that we start with this statement also and the organisers of this particular symposium do recognise that there are problem birds but all birds are not a problem. I think this needs to be stated very clearly, especially for us in agriculture many species of birds are great friends. In fact, living on steady diet of insects, in some cases on rodents, birds are the best 'biopesticides' that I know. We could not have controlled many of the insect pests without the help of birds. Now all that is recognised, but of course is a problem and as far as agriculture part of it is concerned, I like to think on the occasion of this symposium that the problem must be discussed within the broad framework of the changes which are taking place in our agriculture, especially in the last 15-20 years. Because it is in this context that birds assume a particular significance. For thousands of years, I like to think for about 8000 years, we have lived with a traditional agriculture when man, beast and others like birds, found harmonious place. We also have birds in our agriculture which share some of the produce and this was not such a terrible thing when the human population was small, we could afford to share. But today the situation is changing very fast. I am sure all of you recognise i.e., since last 15 years, India is producing 50 million tonnes more of food grains than what we were producing 15 years back. And I would like to think to 2000 A.D. which is not very far, we must produce at least 100 million tonnes more of what we are producing today. That means, we must produce at least 230 million tonnes of food grains by the end of this century. Now it is in the context of this kind of transformation of traditional agriculture that many factors are causing us concern. In a traditional agriculture, as I said, balance is maintained between diverse factors, also you normally define our traditional inputs which don't cause so much anxiety. But in the last 15 years, all have sustained very rapidly. Many of you know that India is the fourth largest producer and consumer of fertilizer nitrogen. Many ecologists are reminding us of the danger of nitrate toxicity that could considerably result from such massive use of chemical fertilizers. We are also using a great deal of pesticides, about 500 grammes per hectare for the first time in our agriculture and again this is a matter of some concern. India, I am sure you know, is the second largest country in the world in terms of its irrigated area. By the end of this century we hope to have 113 million ha. of irrigated land, the largest in the world and that again is

a cause of concern because it could lead to serious problem of soil erosion or loss of soil fertility. Now, when all these problems arise I find that some friends are already digging to solve and going back to nature, going back to traditional agriculture when we lived with the wooden plough and we lived with soil and manure and that kind of thing. Well, I want to ensure you that it is just not possible. We simply can't afford to go back to nature whether it is the problem of birds and I recognise there is increasing problem as the 50 million tonnes of the food which we manage to produce today, do maintain a larger population of birds. Some of you must have wondered that in India the forests have been disappearing rather fast and this should normally have resulted in large decline in the bird population. Such a rapid decline of birds have not taken place due to agriculture replacing forests to a significant extent in the country. If you have about 10 per cent of well managed forests in this country we have nearly 50 per cent of our land mass under crop plants and those are the sources of ecological balance and they, of course, also provide congenial habitat for a large bird population. So agriculture comes in many ways, but as I said the answer simply does not lie in going back to traditional agriculture. If we want to produce 20 million tonnes of pulses, double our production of oilseeds and want to produce 100 million tonnes more food grains by the end of century, I like to assure you that all this is possible. We have technological potential and scientific advances. We have the sources, we have the world's largest irrigation resources. Our fertilizer industry is coming very fast and I feel no reason at all why we should not achieve all these targets in the next 15 years. Even this year with all the harm that have been created due to somewhat unseasonal rains and people are worried, I still like to think, infact I am sure, we will, still end with all time record harvest of wheat. We produced about 36.5 million tonnes last year and I suspect with all these limitations we will manage to produce more than 36.5 million tonnes of wheat this year. These things are moving very fast but the main point is that all this will not be possible with traditional agriculture. We have to use pesticides, we have to use fertilizers. We have to live with bird problems and we will have to find our way and basically at this institute by solving various problems by mobilising more of Indian Science rather than western science. We need more sophisticated Science, we need more sophisticated techniques, for example, in case of insect pests we no longer talk, so much of using insecticides alone as we

have done in past. We daily talk about insect pest management using insect pheromones, biological control, crop sanitation that means use of chemicals which were unknown earlier. I don't know how many of you know a recent technique apart from sterile male technique where we release sterile males in atmosphere so that there can be some kind of family planning in insects. Because sterile males are not so effective as their normal counter parts. We are beginning to use pheromones *i.e.*, the insect behaviour obstructing chemicals. But upto now use is rather limited. We put at one side of the field a small cardboard smeared with a sex hormone in such minute quantity that only insects can recognise and they cluster around it. We use it as a monitoring mechanism to find what is the right stage for applying insecticides. So all kinds of sophistications are coming in, in our battle against insect pests and other problems. In the case of fertilizers, while we certainly will never advocate that Indian farmer should not so efficiently hope to substitute industrially produced nitrogen with biologically fixed nitrogen using, if necessary, genetically manipulated bacteria which is something not impossible with advances in genetical engineering taking place so rapidly. With the answer to all these problems especially in agriculture like the more sophisticated science and I am happy to say that ICAR is very conscious of this. Right at this institute we are now in the process of setting up agro-energy centre and a school of basic biological sciences, genetic engineering, molecular biology and biotechnology which will find answer to some of these problems, of course, I know that the focus today is not so much on agriculture and although agriculture does find an important place, the focus is more on aviation whether it is defence aviation or civil aviation and that certainly is a recent problem but certainly very important one. Again I would like to think that answer probably will be found not by eradication but by manipulations in techniques. Certainly birds with their evolutionary history of perfection in aerodynamics for millions of years probably provide the answer for machine. I suppose that is really not the answer. But I suppose that we must depend upon the control of birds in aviation. We must depend more on their behaviour, more on their ecology as possibilities of these are very great. We have to find their weaknesses and birds certainly have weaknesses. They have adaptive advantages but they have their weaknesses too. One of the greatest weakness, of course, is that they like worms, they like all kinds of dead and decaying matter. They like grains and you can change the ecology

taking into consideration all their likes and dislikes. I feel we can find an answer. I like to think that in this case we have to study the psychology of birds and the psychology as I think lie in availability of food—the grains, worm, dead and decaying animals and that kind of thing. The answer can lie in ecology and other behavioural sciences. Well I probably have taken more time and I end it here. Once again I welcome all the distinguished guests and I do hope with their deliberations we will come to some conclusion.

Thank you very much.



VIVEK R. SINHA

INAUGURAL ADDRESS

VIVEK R. SINHA

I deem it a privilege to be asked to inaugurate this symposium on "Management of Problem Birds in Aviation and Agriculture". At the outset I would like to express my sincere thanks to the Organisers of this Symposium for providing me with an opportunity to share my thoughts with you on the theme of the symposium, especially on problems related to Aviation.

2. As you are all aware, the problem of bird menace which have recently been christened with an acronym "BASH" meaning 'Bird Aircraft Strike Hazard' has assumed National importance and gained awareness among the Authorities, Industry, Airforce and Public as well.

3. The result of this awareness is the primary reason for this symposium wherein all concerned have been brought together to deliberate on this problem in order that a meaningful and effective plan of action emerges.

4. In Airforce alone, the cost of damage or loss due to bird strike on aircraft has been estimated to be of the order of many crores per year. This problem has also been quite serious, in Indian Airlines, the accident rate going up from 20 in 1970 to 174 in 1980. In 1981, 169 bird-hits were experienced. The accident rate has recently been declining which is an encouraging trend and may be due to the increased awareness and preventive measures that are being taken.

5. On April 9, 1982 an Indian Airlines Air-Bus was hit by a vulture weighing 5 kg. as the plane was taking off from Palam Airport. A spokesman of the Airlines is reported to have stated to the press that the forward pressure bulkhead, "a very sensitive part", has been badly damaged. The object of illustrating this recent incident here is, to impress upon the audience the extent of damage a bird hit could cause. The damage could be even more severe, for example, a \$ 20 million military aircraft could well be a heap of scrap on the ground in a collision with any of the 80 odd varieties of birds found near the Indian Airfields. The bird hit could also cause valuable loss of human lives.

6. A point I would like to mention here is that we must evolve our own airworthiness requirements for Combat as well as Civil aircraft since our operating environment is different. To cite an example, as per the laid down airworthiness requirements, a Combat aircraft's windshield is designed to stand an impact of a 2 kg. bird at 750 km./hr. But vulture or a kite more common to India is much heavier and can easily shatter the plexiglass. The real hazard actually lies in bird ingestion by the engines resulting in flame out.

7. In our country, according to newspaper reports, Indian Airlines on an average suffers 6 to 8 hits a month. Between January 1, 1982 to April 30, 1982, a total of 31 bird-hits are reported to have been suffered by Indian Airlines aircrafts. This include 6 on Air-Buses and 12 on Boeing 737s.

8. In respect of Military aviation also the Bird Strike problem has been of great concern and I am sure Air Marshal P.P. Singh will touch upon this aspect in his Key Note address.

9. An analysis of the bird hits indicate that most hits occur during take-off or landing especially as the plane makes a turn

to align with runway. 85 to 90% of the strikes are below 2000 ft. Birds, as you are aware, can be broadly divided into (a) Soaring birds such as pariah kites and Vultures and (b) Non-Soaring birds such as Partridges, Pigeons and Crows. Of the several Soaring birds, Vultures and Pariah Kites have so far been known to cause most of the major bird strikes.

10. The Aeronautics Research and Development Board, which has been constituted to promote Research Development activities in the field of Aeronautics on a National Plane, has been actively promoting research schemes, having direct application in combating the very serious problem of "Bird Strike Hazard to Aviation" faced by both Civil and Military Aviation. The various important projects promoted by the Board on bird strike hazard are :

- (a) To combat the problem of bird hazard, decision has been taken by the Government to constitute Air Field Environment Management Committees (AFEMCs) covering all the Airfields in the country, headed by State Govt., Secretaries/ Divisional Commissioners with participations from Civic Authorities, Airforce, Airlines, Airport Authorities and Scientists. The AFEMCs have started functioning and this has brought about a much closer interaction between the user services who are facing these problems and executive authorities who have to tackle these problems since many of the measures have to be taken outside the airfields. Of course, there is considerable scope for improvement in the functioning of these Committees.
- (b) One of the important reasons for the birds being attracted to the vicinity of the Airfield is environmental pollution in and around the Airfield. The situation gets aggravated by unauthorised slums, eating places, butcheries and injudicious garbage/carcass dumping in the vicinity of airfields. Towards identifying these problems, a project for Ecological study of Bird Hazard in Agra and Ambala aerodromes was sanctioned by the Aeronautics R. and D. Board at a total cost of Rs. 5.01 lakhs to the Bombay Natural History Society (BNHS) in 1980 and a comprehensive report has been issued. Two major recommendations were made by BNHS in respect of Agra and follow-up action is being taken namely :

- (i) Modernising the public slaughter house and effective banning of illegal slaughter houses.

- (ii) Centralising skinning of dead animals and setting up of a large aviary to clean up skinned carcasses.

- (c) Following the outcome of the initial study on two aerodromes, the study has been extended to cover 20 more airfields of interest to Civil and Military aviation and the results of the study would be brought before the respective AFEMCs for priority implementation.

- (d) BNHS have obtained encouraging results in their endeavour to evolve standards for identification of birds from their feathers, i.e., the remnants available after a bird strike which provide clue to the bird species. Simultaneously, BNHS are also engaged in the preparation of a booklet on "Problem Birds in India" as part of their project, which would be published shortly as a AR and DB publication.

- (e) As regards the progress of BNHS investigations at specified airfields they have already begun their studies in Delhi, at Palam and Hindon airfields, as well as at Santacruz, Bombay, with field observations upto 25 km radius of the airfields. One of the major Vulture/Kite concentration area in Delhi is the Timarpur Sanitary land fill where an average of 35 tonnes of animal garbage mainly from the slaughter houses of Delhi is being dumped everyday. I understand that around Rs. 15 lakhs is being spent by the Delhi Municipal Council alone, for garbage dumps and the studies have revealed that Pariah Kites/ White - backed Vultures/White Scavenger Vultures get attracted on the garbage in that order. It is opined that construction of a modern slaughter house, as in Bombay, would lessen the bird problem. In respect of Bombay, I understand, though it has a modern slaughter house, the presence of a sea-coast adds an additional dimension to the problem which needs to be thoroughly studied.

- (f) Concurrently, AR and DB had sanctioned a priority pilot project on Population Reduction of Vultures and Pariah Kites/with the limited objective of reducing bird menace

during the Republic Day fly pasts. IARI as a result of their studies have been able to identify a toxicant, which when applied in low doses under controlled conditions could act as a bird repellent. This project has largely been confined to controlled condition and the approach has to be discussed in depth.

(g) AR and DB is also pursuing with IARI, a project which involves investigation on Non-Toxic approaches to Bird control. This project has been recently sanctioned to IARI at a cost of Rs. 7.4 lakhs. Here again, the general impression one has, based on studies already conducted abroad is that the birds get used to the control measures over a period of time. However, I feel if we could identify a few non-toxic approaches and keep changing them periodically, we might achieve consistent results. I would suggest that this problem may be discussed in this forum and concrete plan evolved.

(h) A documentary film has been made by the Films Division of the Ministry of Information and Broadcasting on this problem. This film would be very useful in educating the public on Bird Hazard and in ensuring that with proper education the environmental pollution leading to bird congregation is reduced and an awareness created among the public on this problem.

11. I am indeed very happy to be associated with this Symposium. This is a commendable effort by IARI, in particular that of Dr. R.A. Agarwal, in bringing together the scientists and technologists in the field to mobilise efforts towards combating the problem of Bird Menace to both Aviation and Agriculture. This is the first time that the problem of Bird Hazard is going to be discussed as a common one for both Aviation and Agriculture, and I am sure, mutually beneficial approaches would be evolved. I feel that a climate has been created now, wherein problem has been identified with reference to Indian environmental conditions. It is in the hands of the scientific community assembled here to make a review of all actions taken so far, analyse them and recommend suitable long and short term actions which would result in greatly reducing the bird hazard by suitable control measures. The birds

have an important role in Nature and elimination cannot be an acceptable solution.

12. I have now much pleasure in declaring this Symposium open. I wish the participants many hours of fruitful discussions and success in their efforts to find satisfactory solution to the bird problem related to Aviation and Agriculture.

KEY NOTE ADDRESS

AIR VICE MARSHAL P. B. SINGH

Dr. Agarwal and other distinguished guests

It is with a great sense of satisfaction that I have been invited to speak on the subject of bird hazard to birds which is a very important and sensitive issue. I am very glad to see that the Government of India has taken such a keen interest in this problem and has decided to hold a Symposium on this subject. I am sure that this Symposium will be a very fruitful one and will lead to the evolution of a concrete plan to deal with this problem.

The problem of bird hazard is a very old one and has been a source of great concern to the Government of India for many years. It is a problem which is not only a menace to the life and property of man but also a menace to the life and property of birds. It is a problem which is not only a menace to the life and property of man but also a menace to the life and property of birds. It is a problem which is not only a menace to the life and property of man but also a menace to the life and property of birds.

As far as the bird hazard problem is concerned, I am sure that the Government of India has taken all possible steps to deal with this problem. I am sure that the Government of India has taken all possible steps to deal with this problem. I am sure that the Government of India has taken all possible steps to deal with this problem. I am sure that the Government of India has taken all possible steps to deal with this problem. I am sure that the Government of India has taken all possible steps to deal with this problem. I am sure that the Government of India has taken all possible steps to deal with this problem.

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KEY NOTE ADDRESS

AIR VICE MARSHAL P.P. SINGH

Dr. Agarwal and other distinguished guests,

It is with a great sense of pride that I stand here this morning to speak on the subject of collision of birds with aircrafts in flight or as we in the aviation circle call it, a bird strike. I am very grateful to you Dr. Agarwal and to Dr. Bhatnagar also for organising this Seminar by which the Air Force and the Civil Aviation will greatly benefit.

The problem of bird strike affected the aviation which in our country is not very large and, therefore, the public as well as the experts on bird control working in other spheres only have a hazy idea. The aim of my talk this morning will be to focus the attention of everyone on this very grave hazard that is faced by everyone who flies in the aircraft.

As seen in the film strip, a bird strike could mean total loss of a modern fighter aircraft, the cost of which in 1979 was upward of Rupees 100 millions and its cost today would be upward of Rupees 14 crores due to escalation of prices. We do not know if the pilot survives. Perhaps not, because of the paucity of time to eject. The cost of human life is beyond calculation. What is on the other side of the balance sheet? A small bird. A lone seagull. The damage due to bird strike is not the sole province of the fighter aircraft. Civil airlines suffer equally at the hands of the birds. My aim is not to give you all the details of the bird-strike accidents but, as stated earlier, to show the problem in sufficient detail, so that it may stimulate you in your respective research programmes to invent suitable means to overcome it.

The first recorded bird strike accident in I.A.F. took place on 27th January, 1954 when a Dakota aircraft suffered a bird strike while on a

Assistant Chief of Air Staff (Flight Safety)

routine flight. Since then, we, in the I.A.F., have been looking at this problem from all angles to find ways and means to avoid bird strike damage. What I am going to say today is the outcome of this research and the experience of other Air Forces of the world. For instance, the film that you saw was from R.A.F. (Royal Air Force).

Why do the bird strikes take place ?

The question is very basic if we understand the heart of the problem. From time immemorial, there has been a tussle for supremacy between the forces of attack and the forces of defence. With the advent of radar and the missile, the forces of air attack can no longer go unchallenged by the force of air defence at higher levels with least warning to the forces of air-defence. This they do by the earth so that the radar cannot pick them up as shown in the slide. By so doing, the flying which some years ago was above the heights at which the birds flew, has now come into the bird layer. The next problem is that the human eye, under the best conditions and directly looking at it, cannot discern a vulture or 'cheel' at a distance of 1.5 km. At a speed of 900 to 1000 km per hour, which is the penetration and combat speed of a modern aircraft, it means only 5.5 seconds. Recognition takes 1.1 sec., reaction time 2.0 sec., control application takes 0.4 sec. and the path deviation by the aircraft 2.0 sec. Then there is the problem of the ever increasing cockpit work load on the pilot. He is getting less and less time to keep a look out for the birds. Roughly 40 per cent of the bird strikes take place during cross country or the transit to target phase of the flight which costwise consumes more money than the remaining 60 per cent of the bird strikes that take place on the circuit or near an airfield. One may well ask that speeds on the circuit are not very high, why can't the birds be seen and avoided? The answer is that during take off and initial part of the climb away, during approach and landing, the speeds are very low and the airframe, the engine, the controls considerations preclude the possibility and desirability of large flight path deviation.

Which species of birds are responsible for the greatest number of bird strike accidents ?

Although there are many species such as pigeons, parrots, crows, partridges, owls and bats that have caused bird strike accidents, our statistics show that quantum wise, as well as frequency-wise, we suffer the most at the hands of the vultures and the 'cheels'. The parrots and

crows are light birds. For their weight and size they are very strong. They fly from their roosting places to their feeding places on muscle power and unlike the heavier birds do not take the help of thermals. They have fixed feeding and roosting grounds and go out in the morning and return in the evening at almost a fixed time. It takes them about 1/2 hour to vacate the airspace during departure and arrival. The crow and parakeet flight level extends only up to about 30 meters and the danger from them is only during the approach for landing and climb away after take off. Fortunately, we must not have too many parakeet and crow strikes, perhaps because it is easy for us to avoid a take off or a landing during the critical 30 minutes in the morning and evening. Moreover, a stray hit by these birds does not produce too grave a damage.

The second set of birds, which we find more dangerous, are vultures and pariah kites. These are scavenger birds who live off the garbage comprising meat waste etc., produced by the human beings, as well as dead animals. Since they are big, heavy and have to locate food, they have to take the help of the thermals for gaining height both for transiting from one place to another as well as locating food. Also, after feeding they soar, perhaps it helps digestion. The 'bird layer' for vultures and pariah kites extends normally up to 1000 meters but they can be found even at 2600 meters and 3000 meters. Since most of our flying is in this layer, we suffer most damage at their hands. As explained earlier, the pilot is not able to take an avoiding action and the bird does not get out of the path, because they are looking at the ground and do not expect other flying objects to collide with them.

Why do 60% of bird strikes take place on the circuit or near the airfields ?

There are many reasons for this but I will state only a few important ones.

Firstly, the air traffic density per unit volume of air-space is highest at and around the airfield because that is where all the flights start from and after an exercise converge for landing.

Secondly, most of the airfields are near population centres. Pariah kites and vultures are scavenger birds, and live off the garbage, butchery waste, fish and poultry dressing waste and the dead animal industry such as tannery. Thus their concentration per unit volume of airspace is highest near the big towns.

Solution :

My aim was to highlight the problem which I hope I have been able to do. For solution, we look to this distinguished gathering. We, however, feel that the future aircraft will fly at faster speed and the cockpit work-load on the pilot will be even more. Thus it will be more difficult for the pilot to avoid a bird. The only way of ensuring safety against bird strike accidents is to ensure a bird-free flying environment. This can only be done by :

- (a) Ensuring that our population centres near which we have the airfields are garbage free.
- (b) Industries based on dead animals, such as tanneries, are reorganised in such a way that they do not stay as the source of food for these birds.
- (c) The meat, poultry and fish dressing and selling industries, are reorganised in such a way that they do not attract the birds.
- (d) Some sort of population control is enforced on Pariah kites and vultures so that without upsetting the ecological balance, they stop being a danger to aircraft in flight. There are chemicals that will perform such a job, if applied carefully. These should be considered.

ADDRESS*

DR. B. VENKATRAMAN**

Dr. Jain, Air Marshal Singh, Dr. Agarwal and friends—I would like to break away from the traditional manner in which the subject has been dealt with so far. Management of problem birds comprise areas where research has to be conducted, studies have to be made taking into consideration, the recommendations that have already been made. I would like to mention that in the field of implementation, all of us should dedicate ourselves and evolve strategies. I am one who is opposed to killing the birds, for the reason that they are not alone responsible for the problem. We have entered into their domain and we want to sort out problems in the best manner that we can. We want to have a very limited area free of birds. After all the total square kilometers that all airports put together cover is very limited. On the civil side, you have 85-90 airports of which only 40-45 are being actively utilized. On the defence side, I don't want to mention but it can't be of the order of 200. It has been less than 100. Now, if we would think of these isolated problems and deal with them in depth, at the end of the process, we may arrive at some specific recommendations. Unlike agriculture, civil aviation has to be treated on a quite different footing. Because in agriculture, it is the problem of 'living with them and letting them live'. In the case of civil aviation, we don't want them to live in the premises where we are living. There is a total difference in the approach. We would like to keep the bird away from airport, say, at the distance of 14-15 kilometers. I, therefore, would not waste your time. On the other hand, I would like to look forward, in getting recommendations from you as to what we should do at the implementation stage. I am Chairman of the Committee of the very senior officials and non-officials who are constantly engaged in the task of recommending to Government what the various measures are and which should be taken in order to solve

*Adapted from the recorded speech of the speaker.

**Secretary, Ministry of Tourism and Civil Aviation.

this problem. A number of people have spoken about as to how this problem is to be sorted out and a very elusive disposition has been given to us. Many scholars and people of eminence are here and will speak to you. I would like to come to seminar at the end and listen to the summation of the recommendations and would like to hope that with me as the Chairman, in the course of couple of years, at least, we will implement 50% of the recommendations to be implemented. Very often it is said that funds are constraints. In my judgement, funds will not be a constraint for the reason that our losses (in terms of actual repair losses) in Indian Air Lines alone will be of the order of Rupees 2 crores. And in respect of losses by their revenues it is Rupees 6 crores. So, I always request Indian Air lines to provide Rupees 6 crores plus 2 crores in order to look after the birds. We don't want to show Rupees 11½ crores of profit in order to show that we are doing very well. We would rather provide that money in settling this bird menace. I don't want to use the word bird menace strictly in the sense that they are damaging us. We are entering in their field. We should allow them to fly in the air. It is not possible to eliminate them. It is possible to contain them away from our airports. Within the Air India and Indian Air lines, I am sure you should be able to get couple of crores of rupees as grant from them. I should give to you not radical recommendations to mark high frequency dispersal techniques and laser techniques, etc., which will not be implementable. I would like you people to make specific, concrete and practical recommendations which I, as Chairman of the committee would like to implement. I would not like to waste your time but like to listen to the eminent people. I am an implementation man and I will be very happy if I am able to implement your recommendations. Some of you would have to look forward something also from it. Since we are running short of time, I like to cut-short my talk. I like to join at the end when you come up with your recommendations and then I take them home to study them. Thank you very much for giving me this opportunity. What has made me so happy and delighted is that all the top scientists of the country have assembled here to solve this problem. Please go back with the feeling that there is one i.e., civil aviation side which is totally receptive to your recommendations. If I fail to implement your recommendations it is due to reason beyond my control. But I am sure that there are lot of things within my control.

Thank you very much.

MANAGEMENT OF PROBLEM BIRDS TO AVIATION AND AGRICULTURE

R. A. AGARWAL

Respected Shri Sinha, Air Vice Marshal P.P. Singh, Dr. H.K. Jain, distinguished scientists, delegates, and participants, I would like to place some of my views for those who are deeply concerned with the problem of birds, also on the needs and objectives of organising this seminar on "Management of Problem Birds in Aviation and Agriculture".

Bird is a word which is taken with a smile. Common man understands it as a symbol of "Freedom and carefreeness". The birds have always occupied an important place in human life. Poets, artists and naturalists have adored them. We have often heard the saying "Singing happily as a lark".

The birds have been classified into 29 orders spreading to 154 families. There are 8600 known species of birds in the world. Out of them 1200 species grouped in 70 families and 20 orders are found in India. However, nearly 400 species of birds are common both to Agriculture and Aviation.

In India the scientific studies on economic ornithology were first started in 1905 at this Institute by late H.M. Lefroy. The first publication on birds "Food of birds in Agriculture" came out in 1912 from this Institute. It was later supplemented by T.B. Fletcher and C.M. Inglis by publishing a series of articles on some common Indian Birds during 1922 to 1924. The bird problem particularly about the parakeet has siezed agricultural scientists for a very long time. Munia (*Estrilda sp.*), as the name goes is a very small bird. It is capable of extracting grain

from wheat plants while the crop is in the ripening stage. It is a sight to see this bird picking out grain from ears while sitting on the plant without much bending it.

The economic ornithologist identified the beneficial and harmful birds. They studied their behaviour, food habits and ecological changes of the life systems of birds. However, the birds form an important component in natural balance. Several bird species help in pollination of plants and dispersal of seeds. The typical example is the dispersal of the mulberry plant which helps in checking the erosion of canal banks and the spread of sandal wood seeds. The wide dispersal of common and lantana weed are also attributed to birds. Insectivorous birds predate upon insect pests and effect natural biological control. It is possible to multiply the population of useful birds in certain areas by using artificial bird nests. Among useful birds, drongo destroys large number of larvae and beetles found on crops. They can be utilised to limit the population of insects. Thus birds have an important role in overall strategy of integrated pest management.

Unlike other animals, in birds food consumption is directly related with body weight, temperature and their physiological conditions. The recent past has witnessed many changes in bird habitats. There have been a large scale deforestation. Besides, many forests are getting less dense and humid. These changes in habitats of bird fauna has affected their behaviour, life patterns, a shift in their food habits and possibly migration to other congenial areas having abundant supply of food. Besides the fast urbanisation, bringing under plough vast areas not cultivated earlier have greatly aggravated the bird problem.

The green revolution has made an impact on the cultural and economic life of people, wherein food habits have changed and standard of living is also raised. This period has witnessed a tremendous increase in inter-and intra-national movement of people as tourist, for trade and through air. This has created many other problems. One of them is that today we are caught in a situation where animals which were a source of joy and were considered of little significance have become a source of great concern to farmers and pilots.

Thus the urge to produce more per unit area and per unit time has brought many problems. To protect crops from insect damage

more insecticides have been used. The increased use of insecticides has resulted in environmental pollution, health hazards, killing of non-target animals and finally it has created an imbalance in nature. Similar chain reaction has taken place in case of birds hazardous to aviation. The great increase in the consumption of animal food in big cities has resulted in the explosion of population of vultures and pariah kites. Today, Delhi alone has approximately 22000 vultures, in addition there is an unknown number of pariah kites also.

The obvious question arises do we really need this huge population of vultures and pariah kites for scavenging food wastes? Is this population not a danger to our environment? Is it not causing an imbalance in nature by their preponderance in biosystem? This unprecedented increase in vulture and pariah kite population is certainly a very serious matter. They are a very great threat to the safety of pilots, air passengers, besides loss of air crafts. The magnitude of problem can be judged from the fact that there have been 39 bird hits from January, 1981 to April 1982 i.e., on an average one hit per 11 days. Besides between 1977 to 1979, there were 213 mishaps. Delhi had 36 hits, Bombay 21 and Calcutta had 13 hits in the same year. During the last 11 years, i.e., between 1970-81, the IAF has had as many as 800 bird strikes.

Similarly, several estimates on loss by birds to food grains and fruits have been made. But none has so far been able to give a correct estimate of loss caused by them. According to these estimates the loss by birds range from 5 to 50 per cent. Therefore, there is a need to study the losses caused by the birds under Indian conditions to food grains and perishables etc.

The management of birds by various methods e.g., scaring them by guns, beating of drums, use of acetylene guns, netting, manipulation and cultural practices, use of electric perches, pyrotechniques, bioacoustics, use of chemicals and sticky substances, stupefying and frightening substances (broadcasting of 4 aminopyridine baits), repellents and deterrents etc., have been suggested. But most of these studies have given a very limited success. There is therefore a need to have intensive researches on such parameters as this will be a very useful component in the integrated bird management system without resorting to killing them.

The problem of bird management either for agriculture or for aviation is not simple as several biological systems are involved, all reacting in opposite directions.

I may put 3 points for the consideration of the distinguished participants :

1. Can we suggest the reduction in the present population of vultures and pariah kites by 50% to reduce the corresponding possibility of hitting the aircrafts.
2. Could we have a strong legislation to remove all garbage dumping grounds away from air funnel.
3. We may also have a strong legislation to the effect that no animal or food waste is left uncovered around the airports.

I hope all these points will be discussed during the course of the deliberations in the seminar. In the end, I also welcome you all to this seminar, which will certainly generate many more ideas and will serve as a guideline for future work and suggest ways and means to face the present problem of birds.

In the end, I may suggest that the subject of bird science particularly in relevance to aviation is still in its infancy in India. This is probably the first attempt in this direction when scientists of so many disciplines are participating and presenting their experiences in the form of papers. These contributions will be of immense interest and scientific value. Therefore, all the papers and the discussions held in this seminar should be published in the form of a book so that the information generated in these two days is communicated to future workers. I offer all technical help for its publication, if only sources for funding the publication are found out.

BIRD STRIKES TO AIRCRAFT AND ASSOCIATED HAZARDS AND PROBLEMS REGARDING THE SAFETY OF AIRCRAFT OPERATIONS

H. B. SINGH

Introduction

We have, by now realised that there is very little that the pilot of a heavy airliner can do to avoid an unforeseen collision with birds. In fact, birds and aircraft have collided causing damage almost from the beginning of aviation. In early days aircraft flew at low speeds and birds could at times be avoided or they could get out of the way. The first recorded fatal air crash occurred in 1912. Since then, as both the speed of aircrafts and number of flights have increased, so have the incidents involving bird strikes.

Study of vital statistics records reveal that there were a total number of 3028 bird-strikes over the world in 1970. Of these, 60 per cent occurred to engine and engine cowling, 15 percent to fuselage, 13 per cent to windshield and 3 per cent to nose.

Considering the distribution by time of the year, data for the last 4 years in Fig. 1 and 2 (see on next page) shows that the number of bird strikes per month to Indian Airlines aircraft was the highest in October followed by August. This mainly depends on the species of birds and their abundance in the vicinity. The height-wise distribution indicates that upto 75 per cent of all the strikes to Civil Aircraft occur upto 60.96 meters. In U.K. this figure (1966-71) was 86 per cent upto 60.96 meters and in India 76 per cent of strikes occurred upto 152.4 meters, AGI. Again considering distribution by flight phase, the world data

shows that about 45 per cent strikes occur at the time of landing, 38 per cent during take-off and 14 per cent during approach.

Once again, considering the distribution by aircraft speed, it will appear that in civil aviation, most bird strikes occur at relatively low altitudes, with aircraft flying well below their cruising speed. A general speed-wise distribution chart will show maximum number of strikes (25-30 per cent) between 80 and 160 knots.

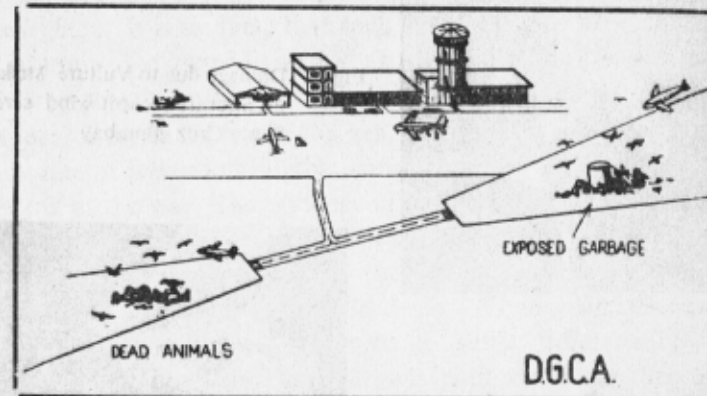


Fig. 1 Diagrammatic representation of Bird Problem at 'approach' and 'take off' due to Scavenging Birds

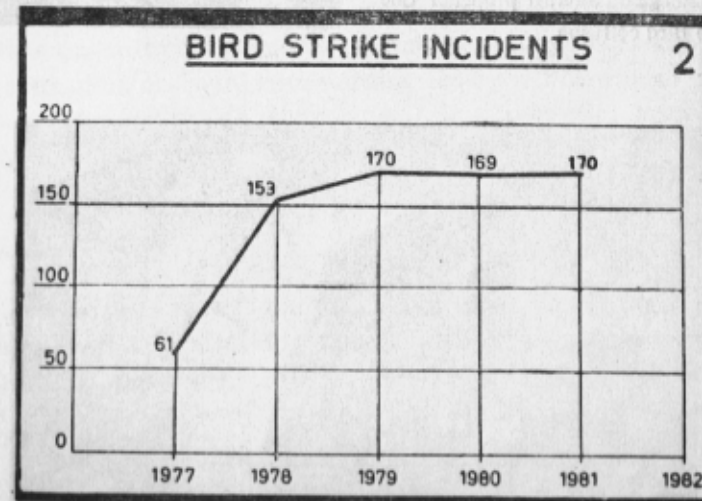


Fig. 2 Bird Strike incidents in India during years 1977-1981

The problem birds in the context of aviation in India are mainly the white backed vulture and the Pariah kite. The vultures are not known to attack the aircraft but their bulk makes them much slow to

avoid them and have been involved in many serious strikes. The purpose of this paper is to promote safety consciousness by pointing out to some aspects of bird-strike problem. Fig. 4 to 6.



Fig. 4 Damage due to Vulture strikes on an aircraft cockpit wind screen at Santa Cruz, Bombay



Fig. 5 Damage on aircraft propeller due to Bird collision.

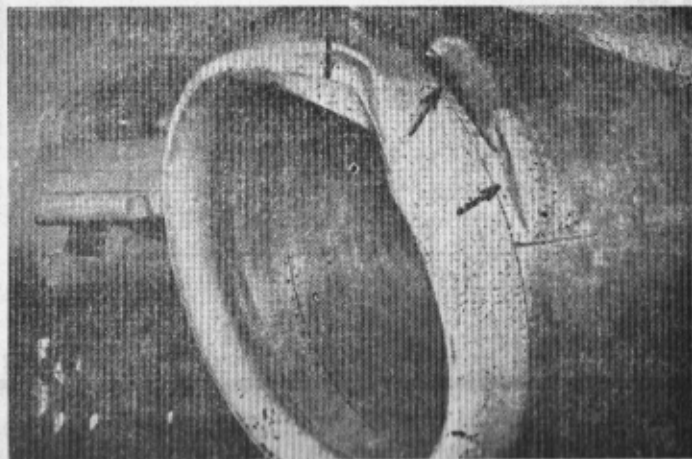


Fig. 6 Bird hit damage on nose cone of VT-EAK on 6-9-81 at Agra

Bird Proofing

The search is 'ON' for on-board equipment to dispense with birds. What we exactly need is to convey the message "Get out of my way". Now this appears to be a tall order. Such a device has to be effective on birds of all species under all conditions, has no harmful effect on humans, causes no adverse affect on aircraft performance, be readily installed, operated and maintained and, above all, be of reasonable cost and weight. It is unlikely that such a device will be available in the near future. On board lights have been tried with some success. It is not known whether birds that avoid aircraft do so because of the noise, the appearance, the speed or the general un-naturalness of the aircraft. At any rate, it seems logical that conspicuous birds would get more time to get out of the way. The presence of strong lights on aircraft would give the birds more time to detect and to anticipate its flight path. However, there is no proof that use of air borne strobe lights reduce the number of bird strikes. Two comparable airlines "Flying similar equipment to indentifical airports" were reported to suffer different bird damages against airline using strobe lights which paid much smaller repair bill. Some special coloured paint on nose of the aircraft also may make the aircraft conspicuous to the birds from a distance, giving them time for evasive action. On board, laser has also been tried. More research is clearly required to determine the usefulness, safety, technical feasibility and costs of an on-board laser warning device. There is no doubt that microwaves affect birds at short range. But, to be effective, an on-board microwave source would have to be extermely powerful. For this reason, this idea too does not appear feasible at the present time.

Preventive Action

We are all aware of the fact that the main factors that cause birds to flock around the airport are food and water supply, roosting area and migratory stopover. These factors are largely controllable. "Anti-bird operations" on and near the airport fall into three general categories.

1. Dispersal of the birds to reduce their immediate hazards to aircraft.
2. Scaring the birds out of their established roosting and nesting areas so that they will not return.
3. Alteration of topography of the area to reduce its attractiveness to present and future generations of the birds.

Most dispersal methods affect bird's faculties of sight and hearing. Birds quickly become accustomed to frightening stimuli that there are no real danger. To prevent this habituation, the stimuli have to be changed often or reinforced by other means. Birds are hard to fool. That is the main lesson man has learnt from his many attempts to frighten them. Temporary successful results can be obtained by exhibiting stuffed birds in abnormal positions. Encouraging results were obtained from New Zealand where corps of black-backed Gulls were nailed on boards. This eliminated gull flocks. Usually effects lasted for as long as the corpse was reasonably tidy ; about three months.

Some accoustical scaring methods have been used. These include (a) ultra-sonic sounds (b) non-natural sounds (Clang hangers etc.), (c) natural sounds (e.g. taped distress calls of birds) and synthetic sounds (experimentally developed sounds). Ultra-sonics had little effect. In fact most birds can not hear them, and if they could, these high frequency sounds would mean little to them and even if it did mean something, its use over a large area would be impractical. Recording of distress calls is not easy and often requires a lot of patience. The system must include studies to determine (1) what species cause what problem, at what time of the year and of the day (2) what calls can be used to scare the birds and how they can be obtained (3) the minimum quality requirements in both taped calls and the play back equipment to obtain satisfactory results (4) the best way and rate of broadcasting (5) the best additional stimulus to reinforce the effect and (6) what can be done to prevent habituation ? Clearly, much R & D effort is required and final results may be well worth the investment. Finally, combined visual and accoustical methods like pyrotechnics, setting up models of birds of prey (visuals) and a radio controlled model aircraft have been used. A mobile aggressive, imaginative and persistent patrol group will be able to get rid of most problem birds. The elimination of a local bird problem by eradicating all existing birds will, from a practical point of view, be only a stop-gap arrangement, because other birds from the vicinity of airport will soon move-in.

Habitat Manipulation

The method which is most effective in the long run is alteration of the ecological condition of the airport and its surroundings to make the area less attractive to the birds. The studies conducted by the Bombay

Natural History Society will suggest ways and means to change the ecological conditions of the problem areas. However, major airports located in bird-rich areas will continue to have bird problem even when all possible habitat changes have been implemented. This residual problem will be relatively small and the remaining birds can be driven off more easily because fewer attractions are available and effective dispersal techniques have been developed. At best, a bird dispersal team, or atleast some bird scaring capability will still be needed for maximal flight safety.

The most common obstacle to any ecological approach is lack of funds or rather, a lack of proof that costly changes in the airport habitat will pay in the long run.

Measures Taken to Fight Bird Problem

Recognising the severity of the problem, a high powered Bird Strike Committee has discussed the problem in detail and a number of decisions have been made. On the basis of data supplied by the concerned agencies, it was decided that Delhi, Bombay, Hyderabad and Trivandrum be regarded as High-bird-strike-hazard airfields while Madras and Bangalore at medium-bird-hazard airfields. It was decided to take up the following work on priority :-

- (a) Cutting of grass
- (b) Spraying of insecticides
- (c) Spraying of diesel emulsion.
- (d) Sodium Vapour Lighting for apron and Mercury vapour Lights for car park areas.
- (e) Incinerators for Garbage
- (f) Shooting.

Whatever be the details of a particular bird control programme, cooperation between airport personnel and the citizens is essential. Workers on outdoor construction sites often contribute to the problem by leaving scraps of food. Such things even airport officials contribute unintentionally. It is essential that these practices be stopped.

Cooperation between airport incoming and departing aircraft has to be developed. Monitoring and informing large gatherings of birds on or near airports to pilot by the tower and where possible and advisable,

the aircraft may be directed to use different runway than the one selected.

Conclusions

An effective bird hazard reduction programme should be undertaken with objectives to minimise the day-to-day bird hazard to aircraft caused by flocks of birds that frequent airports. All efforts be made to reduce or eliminate those features of the area which are found to be attractive to the birds. This programme is dependent on a dedicated direction from a high level authority for management that can ensure adequate funding, manpower and continuity of specific programme(s). There must also be close cooperation with and the support from local municipal agencies and support from local population. All employees of the airport must be well aware of the programme and the importance of their roles in it. Information concerning the bird population and distribution must be right-up-to the minute and available for transmission to the departing and arriving aircraft. This way, we can minimize both the potential hazard and the damage with an aggressive, well planned programme.

MANAGEMENT OF BIRD PROBLEM IN INDIAN AIRLINES

R. P. BARNWAL

Introduction

Nature has created a number of living-beings which are useful to the human race. Birds are one of them. The Wright Brothers took their powered aircraft into the air in 1903 and shared the sky with the birds; the risk of collision has existed since then. The first encounter between the bird and the man in a powered aircraft took place in 1912 in which both died.

Civil Aviation has been keeping the record of bird strikes since 1946. As the aircraft flew faster and got bigger in size, the chances of bird strike increased. The first major accident to an airliner took place at Boston in 1960 when a flock of birds hit the Electra aircraft immediately after take-off. There was power loss and the aircraft crashed killing 62 of the 72 persons on board. The reported number of bird strikes revealed that United States averaged between 1200 to 1400 a year, costing approximately Rs. 20 crores in repairs only. The estimated cost of the repairs of the damaged aircraft due to bird strikes in the whole world works out to approximately Rs. 10,000 crores per year.

Analysis of the bird problem in Indian Aviation

Most of the International airlines operate through the Indian Airfields during the night. As such they rarely run the risk of bird-strike on the Indian soil. On the other hand, 90 per cent of the Indian Airlines operations of about one lac take-offs per year are during the day. Hence the statistical data on bird-strike in which IA aircrafts are involved can be considered to be representative of the problem of bird strike at Indian Airports. Now we will analyse the bird problem to Indian aviation from five different aspects i.e., the total loss of revenue and the

Indian Airlines, New Delhi.

type of aircraft (Plate-7A), the months, the bird species and the Indian airfields which are most vulnerable to bird strike :

The number of bird strike incidents to IA aircraft for the last four years along with the approximate cost of repair and the approximate total loss of revenue is given below :

Table 1 : Estimated cost of repairs and revenue loss due to Bird Strike to IA Aircrafts

Year	No.	Approx. Cost of repair	Approx. Revenue loss calculated by this rule
1971	19	—	—
1972	15	—	—
1973	43	—	—
1974	27	—	—
1975	26	—	—
1976	61	—	—
1977	76	—	—
1978	86	150 lacs	6 crores
1979	107	25 lacs	1 crore
1980	141	20 lacs	8 crores
1981	121	102 lacs	4 crores

The National Transportation Safety Board submitted a report to the United States Senate, highlighting the possibility of simultaneous damage to more than one engine. The situation has become more critical today because a large number of present and future generation Jet aircrafts are equipped with only two engines. The situation is still more critical for Indian Airlines which operates only two-engined turbo-jet aircraft. In the event of birds getting sucked into both the engines just after passing the critical speed on take-off it could be disastrous, with a possibility of total loss of men and equipment. The fleetwise bird strike incidents to IA during 1980 for every 1000 take-offs was air bus 2.2, Boeing 1.6, Avro 1.5 and F-273 (Plate-7B).

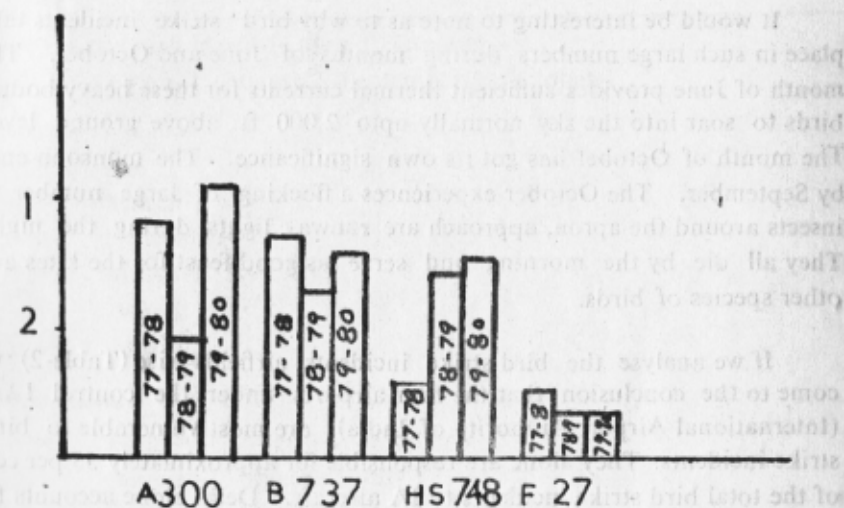


Fig. 1 Bird Strike incidents on Indian Airlines Aircrafts/per 1000 take off

From this it is apparent that the Airbus aircraft which has a big by-pass engine with a large suction area is most vulnerable to bird strike. The FAA have advised the three manufacturers of the big turbo fan engines i.e., M/s Pratt & Whitney, M/s General Electric and M/s Rolls Royce to consider strengthening of the components to withstand bird impact forces.

The Indian aircrafts are subjected to bird menace from only two species of birds. Approximately 90 per cent of the birds involved in the incidents are kites (cheel). The rest 10 per cent of bird strike incident are due to the vultures.

All over the world it has been observed that the number of bird strikes increased considerably between March and May, drop off during the summer and rise again during September to November. The experience of Indian Airlines also has been somewhat similar. The highest number of bird strikes has been experienced during the month of October which account for approximately 20 to 25 per cent of the bird strike incidents for the whole year. The second most vulnerable month for bird strike is June which accounts for approximately 10 to 13 per cent of the bird strike incidents for the whole year. Thus we can say that the months of June and October alone accounts for more than 1/3rd of the total number of bird strike incidents during an year.

It would be interesting to note as to why bird strike incidents take place in such large numbers during months of June and October. The month of June provides sufficient thermal currents for these heavy bodied birds to soar into the sky normally upto 2,000 ft. above ground level. The month of October has got its own significance. The monsoon ends by September. The October experiences a flocking of large number of insects around the apron, approach are runway lights during the night. They all die by the morning and serve as good feast for the kites and other species of birds.

If we analyse the bird strike incidents airfields-wise (Table-2) we come to the conclusion that the four airports under the control IAAI (International Airport Authority of India) are most vulnerable to bird-strike incidents. They alone are responsible for approximately 55 per cent of the total bird strike incidents to IA aircraft. Delhi alone accounts for approximately 25 per cent of the total bird strike incidents to IA account. The bird strike prone airfields which are under the control of the DG CA (Directorate General of Civil Aviation) are Hyderabad, Trivandrum and Patna. Agra, Srinagar, Jammu and Cochin are the other bird strike prone airfields which are under the control of Defence Ministry.

Table : 2 Bird Strike Statistics to Indian Civil Aircrafts

Year	Month of Bird Strike No. of Strike.	Total
1	2	3
Agra		
1976	October-2,	2
1977	June-1, August-1, November-1	3
1978	March-1, October-1,	2
1979	Nil	
1980	March-1, August-2, September-1	4
1981*	July-1, August-1, September-1	3
Srinagar		
1976	Nil	
1977	May-1, September-1	2
1978	October-1,	1
1979	May-1, August-1, September-1	3

1	2	3
1980	June-1, April-1, May-1, October-1	4
1981*	March-1, August-2, September-1, October-1	5
Jammu		
1976	Nil	0
1977	March-1	1
1978	November-1,	1
1979	March-1, August-1	4
1980	July-1,	1
1981*	April-2	2
Hyderabad		
1976	January-1, August-1, October-1	3
1977	January-1, March-1, July-1 October-2, December-2	6
1978	March-1, December-5	4
1979	March-1, April-1, August-1, September-1	7
1980	January-1, June-2, October-3, November-2	9
1981*	September-6, October-3	9
Trivandrum		
1976	March-1, September-1	2
1977	October-1	4
1978	January-1, May-1, November-2	4
1979	February-1, March-1, June-1, November-2	4
1980	January-1, March-1, April-1, May-1, July-1, December-2	7
1981*	May-1, August-1	2
Patna		
1976	Nil	0
to		
1980		
1981*	July-1, September-1, October-1	3
Gauhati		
1976	Nil	0
to 1980		
1981*	September-1, October-1 upto 15-11-1981	2

1	2	3
Bombay		
1976	March-2, May-2, June-1, August-2, September-3, October-2, December-1	13
1977	January-2, February-1, March-1, May-2, June-2, July-2, August-1, September-1, October-1, December-2	15
1978	January-1, February-2, May-2, June-2, July-1, August-1, September-1, October-4, November-3, December-2.	19
1979	February-2, May-2, June-2, July-2, August-1, September-1, October-2, November-1	16
1980	January-3, February-1, March-3, June-9, July-3, August-2, September-1, November-1, December-2	25
1981*	April-1, May-1, August-2 September-3, October-2	9
Calcutta		
1976	January-1, March-3, October-2, December-1	7
1977	January-1, April-1, July-1, August-2, September-1, October-2, November-4	9
1978	February-2, April-2, May-1, June-1, September-1, October-2	9
1979	January-1, February-1, May-2, August-2, September-2, October-3, November-1, December-1	13
1980	March-1, April-1, May-1, June-1, August-1, October-1, December-1	7
1980**	January-1, February-1, March-1, April-1, May-1, June-1, September-2, October-3	11
Delhi		
1976	April-1, May-2, June-2, August-2, September-3, October-3, December-2	15
1977	March-1, July-4, August-1, September-4, October-1	11
1978	January-1, Feb-1, March-1, April-2, May-2, June-1, July-2, August-1, September-2, October-3, December-2,	19
1980	January-1, February-2, May-5, June-5, July-1, August-4, September-5, October-9, November-3, December-2	37
1981**	January-1, March-3, April-3, May-2, June-2, July-5, August-3, September-3, October-2	
Madras		
1976	June-1, July-1, October-4, November-2, December-1	9

1	2	3
1977	June-1, July-1, August-1, September-1, November-2 December-1	7
1978	March-1, May-1, June-1, July-1, August-1, September-1, November-3	7
1979	February-2, June-2, August-1, December-1	5
1980	January-1, February-1, April-1, May-1, October-4, November-1, December-1	10
1981**	January-1, February-3, April-1, September-3, November-2	10

**Figures are upto 17-11-81.

Management of the bird problem in Indian Aviation.

The bird problem has to be managed at two levels. The long term measure should consist of removing the pollution from the surroundings and the attractant for the birds from the vicinity of the airports. Whether we succeed in the long term measure or not we must watch the birds and drive them away or avoid them for safer flight operations. This is the short term measure which has to be given a higher priority.

A high-powered Committee at the National level has been formed under the Chairmanship of Secretary, Ministry of Tourism and Civil Aviation, Dr. Venkataraman. The members of the Committee are from the DGCA, IAAI, the IAF, IA (Indian Airlines), the AI (Air India) and from the specialists. The committee meets practically every month. It has laid down general guidelines to be followed by the authorities of the airports. They also monitor the effect of the measures taken with the help of the statistics obtained recently.

Local committees have also been formed at various airports which are vulnerable to bird strike incidents. These committees are getting guidelines from the national committee and the DGGA or IAAI or IAF under whose control the airfield lies. Suggestions given by the IA are also taken into consideration by these local committees.

All these committees are functioning very nicely at the planning level. What is lacking is consistency in the implementation by the local airport authorities. The following ten point action plan is suggested to prevent bird strike incidents.

The National Committee should hold its meetings at all the eleven vulnerable airports by rotation. This will help the National Committee study the peculiarities of the problems of that particular airfield and give suitable guidance and assistance to handle those peculiar problems. The presence of the high powered committee will inspire the local airport personnel to take the project seriously and make a concerted effort.

The local airport committees should be presided over by the head of the local airport authority since he would be responsible for the local bird strike prevention programme. He should conduct monthly meetings of the personnel working under him to educate them about the importance of the project and to motivate them to put their best towards the success of the programme.

The head of the local airport authority should be at the apex to implement the bird-strike prevention programme and he should implement the same with the help of the personnel under his command. He should be given adequate powers and resources to remove all attractions for birds from the airfields. Such of the caterers or the operators who throw food wastage over the operational area should be challaned and very heavily fined.

Since the spraying of insecticide on the grass is very costly and its effect lasts for hardly one or two days, it is essential for a country like ours with limited resources to burn the grass on both sides of the runway. This was tried at Srinagar last year and provided a great success. This can be tried on an experimental basis at some more of these 11 airfields to assess its impact.

A bird strike prevention squad should be formed at these airfields under the control of an airport officer. The squad should be provided with a van which should be equipped with bird scaring hooters, crackers, pyro-technique shots, a gunman etc., besides being equipped with VHF set for a two-way communication with the control tower. The van should standby for the whole day on the side of the runway watching the birds advising the control tower and driving them away before a landing or taking-off aircraft. This is being done at Hyderabad and has provided great relief compared to the 6 bird strike incidents to IA Airbus during September last year.

The authorities at the airport should every month survey the circuit area, the take-off path area of and the approach path area of the aircraft

and locate those spots where the kites or vultures are hovering. They should draw up a list of those spots and take the help of the State Government to get those areas cleared of the attractants for the hovering birds.

The white lights and specially the mercury vapour lights attract too many insects around them. The insects die by the morning and serve as feast to the birds during the day. Hence the authorities of these airports should replace all these lights with sodium vapour lights in the entire operational area.

June and October months alone account for more than 1/3rd of the bird strike incidents. If the IA, the IAF, the DGCA and the IAAI conduct a joint bird strike prevention campaign during these months, it will give a great impetus and encouragement to the local airport authorities. Even if we are not able to tackle the problem correctly, we will have at least the advantage of the Hawthorne effect. IA has printed some stickers for the campaign. Posters are also under print. We wish to start this campaign in the month of October this year with the help of IAAI, DGCA and the IAF.

The help of the specialists e.g., the biologists and the ornithologists should be sought to drive away the kites and vultures from the vicinity of the airport.

A lot of responsibility lies over the pilots to make every effort to avoid bird strikes. They are highly motivated to do so, since their life is in danger. The Director, Flight Safety, had last year issued specific instructions to all pilots not to take-off till the runway had been cleared of all the birds and the take-off path was also clear. The Managing Director has also given clear instructions recently that we do not have many spare engines and pilots should delay their departure or their landing rather than damage the aircraft and risk the life of the passengers. Under the instructions of the management, the pilots keep a slow speed of 250 kts. and a steeper climb rate between the ground level and 10,000' to reduce the bird strike impact.

Conclusion

We as a nation are very efficient in conducting meetings and holding seminars. The recommendation of most of these meetings and the seminars get watered down when it comes to implementation of the

suggestions. Most of these suggestions are noted down on the files and keep on shuttling between one Department and the other till lot of dust is accumulated and the seriousness of the problem is forgotten. This should not be allowed to happen in case of bird strike because this is the greatest danger in aviation today. What is needed is an action-oriented, time-bound programme to be followed by a positive monitoring system and strict follow-up action against the defaulting agencies.

Birds do not want to kill themselves. We have polluted the environment around the airfields which attract birds. If we keep the environment clean, the birds will go away to other areas.

The DGCA/the IAAI/the IAF should tell the authorities of the airports that handling the bird problem is also one of their main functions along with providing ATC services, landing and navigational facilities and terminal facilities. The man power resources and financial resources have to be augmented to achieve success in this area. It is needless to emphasise that the authorities at the airports are positioned at such a place that they can contribute the most towards the success of the bird strike prevention programme. The success of the programme depends on the appreciation, dedication and relentless effort to attack the problem. A temporary success should not put the authorities into complacency. It has to be a continuous effort.

BIRD STRIKES

WG. CMDR. P.R.P. RAO*

Bird Management and Control

Birds in the natural environment can be a beautiful sight. They have an important role in nature and birds can be quite beneficial to man by consuming insects pests. But birds in the vicinity of airports may present a hazard to personnel or cause damage to aircraft and equipment. Bird collisions with aircraft can cost lives, and birds near buildings can create a health hazard. Maintenance and repair costs, total crores of rupees each year and that too in foreign exchange. Regular control of hazard bird problems can prevent many bird problems from developing into emergency situations. To provide airport personnel with basic technical information on birds and their control, the ICAO has developed a manual controlling problems caused by birds. Attached plate 1-5 deal monthly Bird Strike data of four Indian Airports, BASH vs 1000 Aircraft movements, hourly distribution, stage of flight, and species of birds involved in birds. Importance of these is high to various pertinent points to control measures.

Hazard Bird

Status of a bird as a hazardous species depends upon the birds's activities at a specific time and place. Birds cannot be classified as being simply "good" or "bad". A hazard bird is one that is causing *economic damage* to buildings, materials, or equipment or creating a *health* or *safety hazard* to personnel and aircraft by the bird's activities at a specific time and place.

For example, a flock of vultures on the tannery will help keep the area clean by feeding on offal of dead animals that are left and gar-

*Deputy Director, International Airport Authority of India, New Delhi

the are a clean by feeding on offal of dead animals that are left and gar-
 For example, a flock of crows on the ground will help keep
 the are a clean by feeding on offal of dead animals that are left and gar-

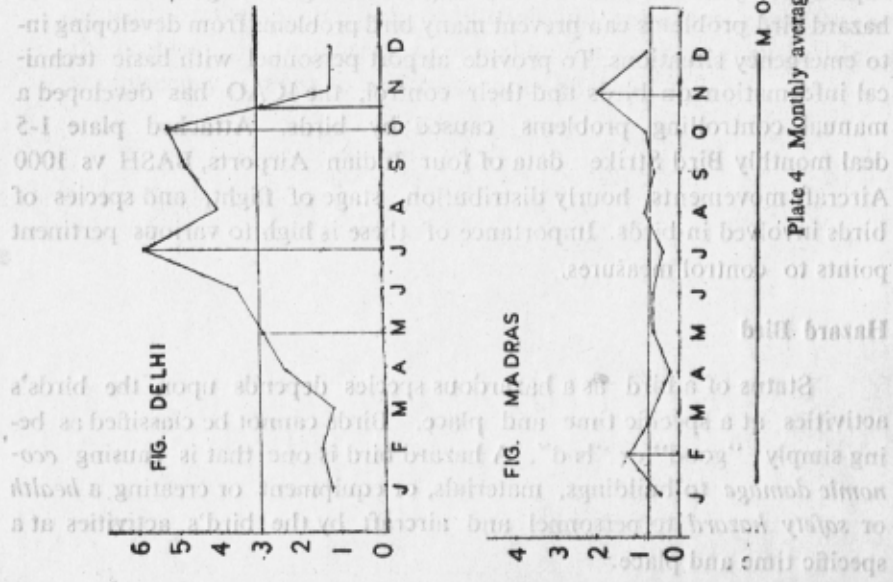


Plate 4 Monthly average B.A.S.H., I.A.A.I. Airport 1977-78

MPH 8 11/211 (24) 01 p11

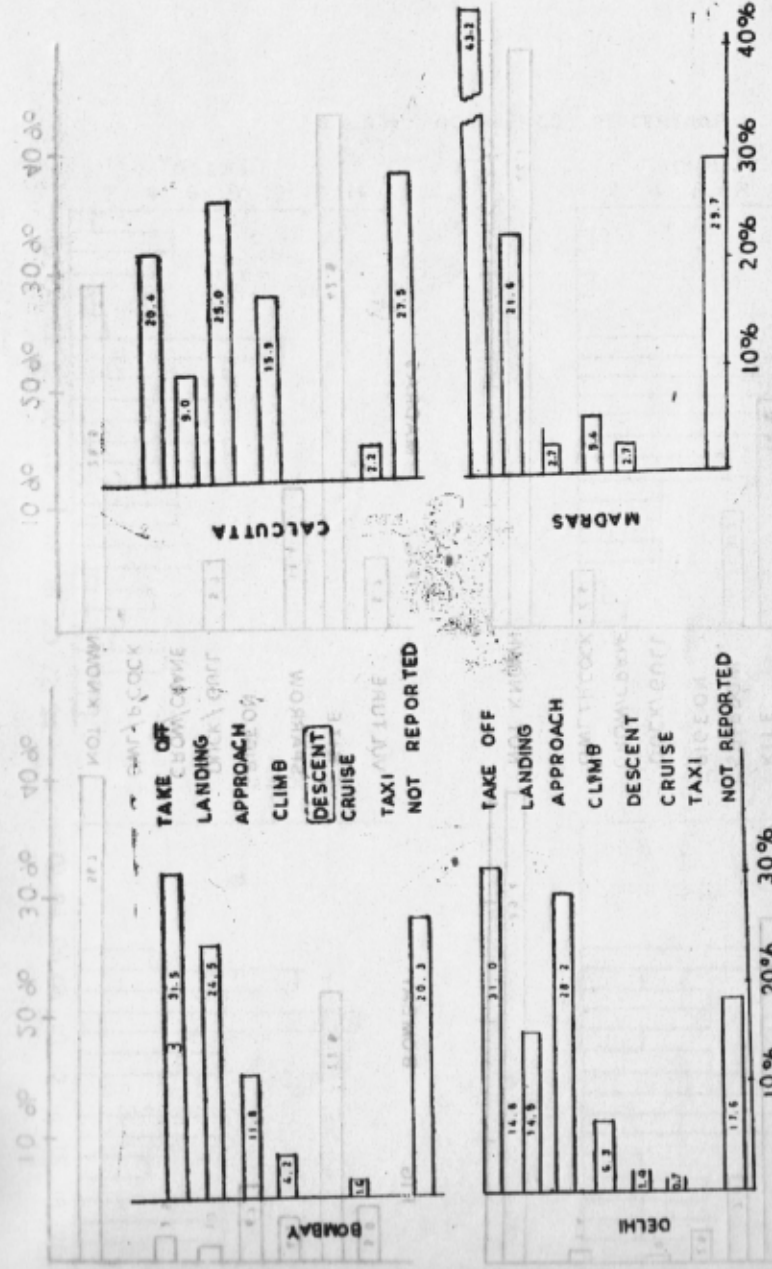


Plate 5. B.A.S.H. & stage Flight

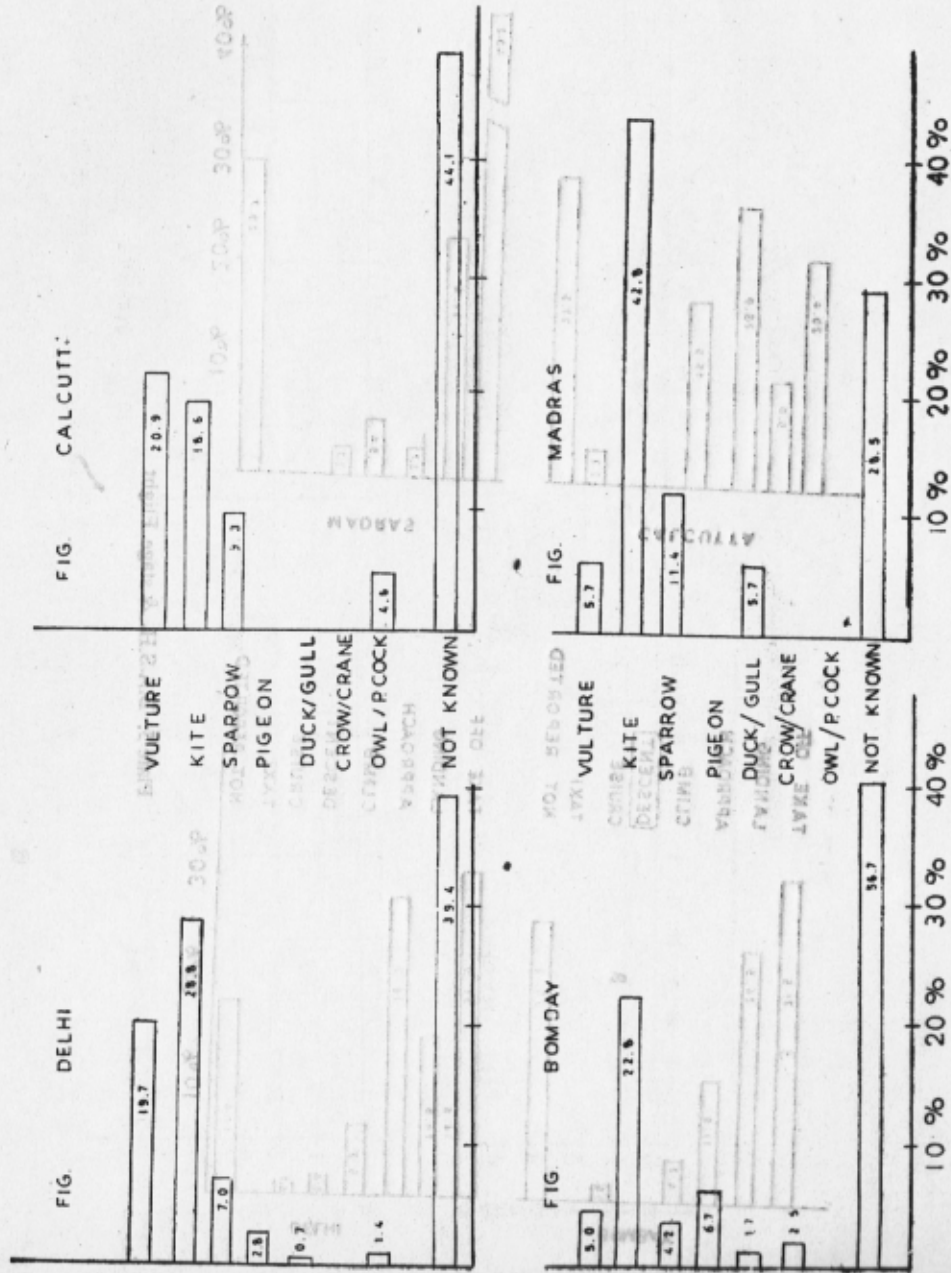


Plate 6 B.A.S.H. type of bird

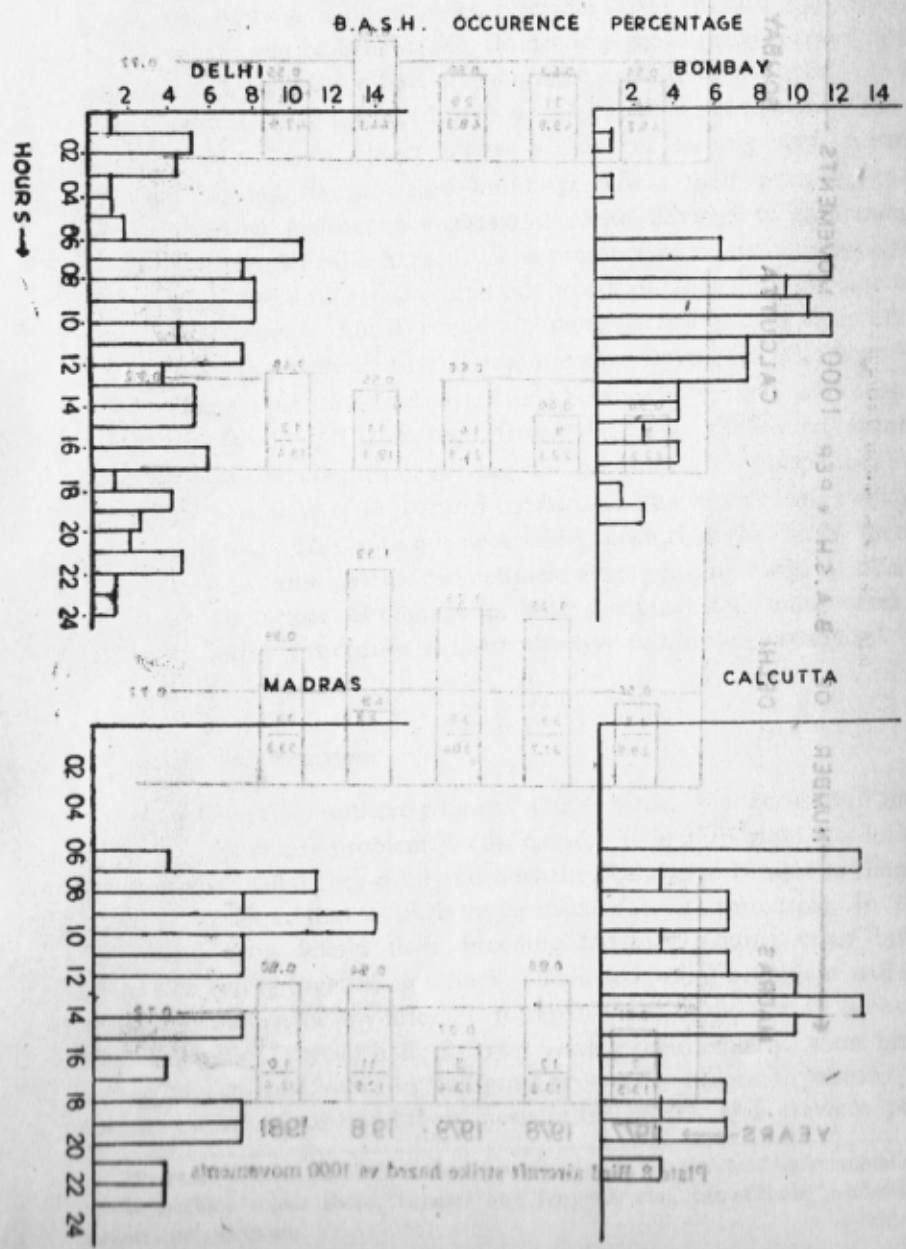


Plate 7 B.A.S.H. hourly distribution

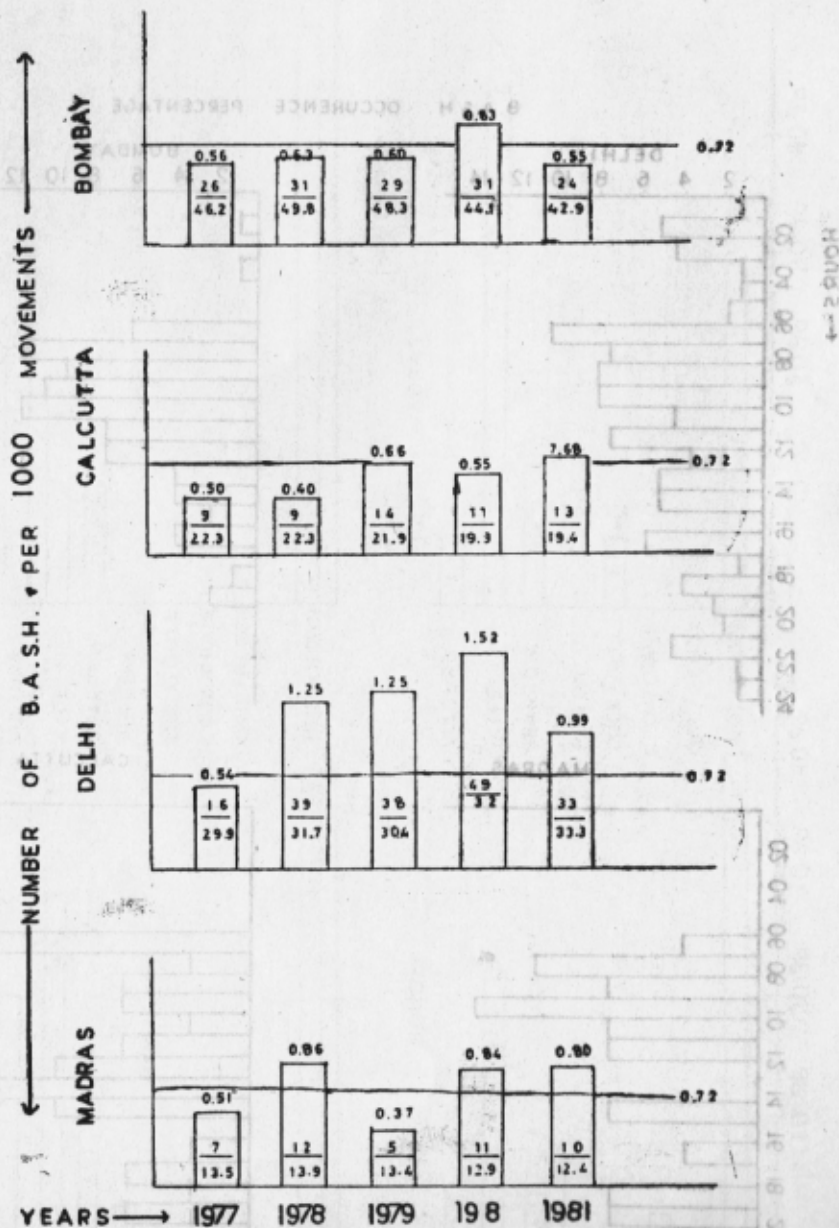


Plate 8 Bird aircraft strike hazard vs 1000 movements

bage left in open by thoughtless people. But vultures on the runway create a safety hazard, because of the danger of a collision between birds and aircraft. This is known as a *bird strike hazard*. Hawks are prized by sportsmen and thus have recreational value; but if garbage near an air base attract hawks, a serious strike hazard may result. Even the pigeons can be beneficial. Domestic pigeons provide sport and recreation for many pigeon fanciers who raise and fly their flocks. And messenger pigeons have delivered news of the battle to headquarters during many wars. But wild pigeons have a habit of nesting and roosting in and around hangers and buildings where their presence can result in expensive maintenance costs and cause damage to equipment and perhaps create a health hazard. The presence of a few birds around buildings might be just a *nuisance* and not worth the time and expense of a control programme* But if economic damage is resulting from the presence of many birds—that is, if maintenance costs are significantly increased because of the bird activities—there are a variety of control methods described in the manual from which to choose an appropriate means of reducing if not solving the problem. The responsibility of the safety authority is to control the hazards and reduce the damage caused by birds. This does not necessarily mean that the birds themselves need to be eliminated. Sometimes, simply killing birds is indeed an appropriate means of damage or hazard control, but more often a non-lethal control procedure is more effective and more economical in the long run.

Bird Biology and Behaviour

More the safety authority knows about birds, the better will they be able to control any problems birds cause. It is important to know how birds live, what they need and how they behave to be able to choose a control technique that is likely to be successful. For example, in the spring many birds defend their breeding territory against other birds rather than acting together in a flock. This territorial behaviour will influence the success of any attempt to repel these birds at this time of year. Each bird species had different nesting requirements, some birds nest on bare ground, other in tall grass or weeds, others in shrubs or trees, and other birds build their nests in the cracks and crevices pro-

*Presence of birds in medical, food, beverage plants, sophisticated instrumentation plants, machine repair shops, hangers and hospitals etc., can at times be affecting serious nuisances etc. —Editors

vided by buildings, where they are likely to create a hazard situation. Many birds migrate each year, flying south in winter and north in the spring-back to their breeding grounds. Many migrating birds follow specific pathways defined by rivers or pathways defined by mountain ridges. So the safety service man should learn which birds are likely to congregate in his area during migration, and when to expect them, so that he can be ready to prevent a strike hazard from occurring. This information can be found in bird books that are available for many areas.

Flocking is another behavioral trait of birds that affects the choice of control technique. Some birds form well-organised flocks that can be chased away as a unit, while other species flock together in a more casual manner. Hazard situations are sometimes caused by flocks of birds that roost together at night in trees, and situations are often caused by other birds that find suitable roost inside aircraft hangers, where their droppings can cause major maintenance problems. Other situations are caused by birds that roost or loaf together during the daytime in open areas, like airfields, which can cause a serious strike hazard. Different kinds of birds have different feeding requirements. If the safety service man learns what birds eat, then he might be able to eliminate the birds problem by removing the birds' food supply, whether it consists of plant materials, such as weed seeds, insects, dead animals, live animals or garbage. A lot can be learned about birds' feeding habits by direct observations and much information is available in books.

Ability to learn is important aspect of bird behaviour, specifically that birds quickly learn to ignore people . . . and to get accustomed to certain control procedures designed to scare them away, just as they have learned to ignore aircraft. This is one reason why a bird control program should include a combination of techniques, to maintain the element of surprise and to reinforce scare tactics with occasional real danger.

Bird Identification :

Different birds have different habits, some control techniques will work on some kinds of birds but not on others. So the correct identification of the hazard birds is important. Several excellent field guides are available for bird identification. The identification of birds in the

field can be challenging and entertaining and requires the noting certain bird features known as "field mark" viz., by the shape of or colour of their bills or the shape or markings of their wings or the shape or markings of their tails. Other details that aid in identification of birds include such things as flight patterns and other behavioral characteristics. Habitat preferences also help to identify birds because some birds are associated with water, while others prefer drier upland areas. The bird communities of open fields are different from the bird communities of wooded areas. Because of their particular habits and habitat requirements, some kinds of birds cause problems more often than others do.

Vultures and kites frequently cause problems at airports because of their habit of loafing in open areas during the daytime. The runways and garbage, thermals at airfields are ideal for them.

Large numbers of crows and vultures are often attracted by the food available at garbage dumps. Dumps in the vicinity of an airfield can create a serious strike hazard.

There are many different species of hazard birds, each being more common in one part of the country than in another. Perhaps the most common being white backed vulture, scavenger vulture kites etc. The scavenger vulture is smaller than the white backed vulture. The wing size and white back is a good identification. Pigeons commonly cause pest problems by roosting and nesting in and around hangers and buildings. The House Sparrow is another native species. These roost and nest around buildings, and their messy living habits frequently make them unwelcome neighbours. Similarly birds like Starlings Mynas which often roost and flock, frequently nest in cavities created by buildings design and construction flaws. These may roost in aircraft hangers in large numbers.

Parrots black birds, like starlings, have a habit of forming large flocks that can create a strike hazard when birds are arriving at a roost at sunset or leaving the roost at dawn. Feeding flocks can also present a problem. There are a number of species of Blackbirds, including the Red-Winged Blackbird, the Common Grackle with its long, wedge-shaped tail, and the smaller Brown-Headed Cowbird.

Although collisions with large birds are obviously dangerous, strikes involving much smaller birds such as Starlings or Swallows can also

result in damage or loss of aircraft and lives. Starlings and House Sparrows can build a nest within a matter of hours, and they may select what might seem to us to be unlikely nesting locations. Nest material in dismantled aircraft can result in later malfunction of controls or engines, unless discovered and removed. A preventive maintenance program within hangers is the best way to avoid such bird problems.

Health Hazards :

Birds can be associated with an assortment of diseases including histoplasmosis, psittacosis, and encephalitis. Pathogenic fungi often grow in bird droppings which accumulate where large numbers of birds consistently roost or nest. Similarly dead birds can also cause a health hazard where people live and work, so carcasses must be properly disposed off by incineration. The safety man must realize the risk for contamination of his skin, clothing and equipment. Always take the necessary precautions and clean up properly.

Management Techniques :

Damage and hazard control techniques fall into five general categories or approaches. These approaches are : altering the concept, altering the situation, exclusion, repulsion, and removal or reduction. For each specific bird problem encountered, the safety man should think through an awareness of the variety of techniques available in each category. Each successive approach should be rejected only if it is concluded that no acceptable technique, that is likely to be successful, exists within that approach for the specific problem at hand. With experience the safety man will learn to immediately identify the best technique for a given problem.

"Altering the Concept" means thinking about the apparent bird problem in a different manner, and perhaps deciding that no active control programme is needed or justified. After careful investigation, it might be decided that the activities or the location of the birds in question do not really pose a problem after all . . . or it might be determined that the birds are just passing through on migration and the problem will soon go away by itself. 'Altering the Situation', means

*Spores of pathogenic fungi may spread on drying or when dried droppings are scrapped for cleaning. To avoid this, droppings be moistened with weak solution of formalin—Editors.

avoiding conflict with birds by altering the circumstance at the root of the problem. This includes changing procedures or scheduling flight to reduce the chance of collision between birds and aircraft. Through a bird watch programme, aircrews can be alerted to possible flight hazards due to birds. Changes in operational procedures to avoid birds may include : restricting the use of certain runways, allowing full stop landings only, avoiding long final approaches, and reducing approach and climb-out speeds. This may not be possible to maintain schedules. Perhaps flights can be scheduled to avoid those times of day or night when birds in the vicinity of the air base are most active, such as when birds are arriving at a nearby roost at sunset and leaving the roost at dawn. Also included under "Altering the Situation" is "Habitat Modification." This means eliminating the food, water, nest sites, roost sites or perches that comprises the bird habitat and are attracting birds to the air base. 'Habitat Modification' is the most effective means of controlling many bird problems. Eliminating a food source might mean closing a garbage dump that is attracting large number of birds or by perhaps encouraging proper quicker disposal operations of the land fill, whereby the refuse is continuously covered with soil. Mowing operations can reduce the amount of weed seeds and insects which attract many birds to tall grass areas, as well as reduce rodent populations that might attract Hawks and Owls. Similarly the elimination of water sources that are attractive to aquatic birds would reduce their concentration. Low areas that collect water can be drained or filled by regrading drainage ditches and culverts should be kept unclogged. The open areas could be converted into grassy patches with grass at desired height. 'Dead snags' used as perches by Hawks be removed.

The third major category of control techniques is "Exclusion". This means preventing the birds from gaining access to an area where they would create a problem. Exclusion is most effective when considered during design and construction of new structures, but wire screening, netting or building materials can be added to existing structures to keep out Starlings House Sparrows and Pigeons.

Netting can be installed to exclude birds from the entire upper portions of aircraft hangers. Cavities created by flaws in building construction can be filled with bricks and mortar . . . and open caves can be enclosed with boards or screened to prevent pest birds from nesting there.

The fourth major category of control techniques is "Repulsion" which means scaring birds away by threatening danger or creating an unpleasant sensation. "Auditory Repulsion" refers to making noises to frighten birds, and includes a number of specific techniques. A highly recommended technique for dispersing crows from an airfield or Blackbirds and Starlings from their roosts, involves playing a tape recording of the bird's own distress or alarm calls over a loudspeaker. Another auditory repulsion technique useful for dispersing Gulls is the firing of Shellcrackers with charges that explode in mid air from a 12 bore shotgun. Similarly Pyrotechniques flare shells are fired from a flare gun. These devices are particularly useful as 'reinforcement' for recorded distress calls. The distress calls will get the birds into the air, where they can then be herded away from the airfield by the 'airbursts' of shellcrackers. However with auditory repulsion techniques the keys to success are diversity and persistence, day after day. Birds will learn to ignore the noises, as well as your presence, unless the element of surprise and the constant threat of impending danger is maintained.

Automatic exploders also called gas cannons, produce loud bangs at regular intervals. Because of this regularity, birds eventually get accustomed to the noises; but these device can be helpful if moved frequently and used in combination with other techniques. Another way of repelling birds is through their sense of touch. Sharp spikes can be put on runway markers to discourage birds from perching. Sharp projections, commercially available in strip form, will discourage birds from perching on ledges or other roosting sites on buildings. Application of this material could also be considered an exclusion technique. Sticky materials are available to apply on perching locations to make them unattractive to birds.

Another type of repulsion involves the use of a certain toxic chemical. When birds eat bait, of which a small proportion has been treated with this chemical, a few birds in the flock ingest the treated bait and react erratically. The affected birds exhibit abnormal behaviour and may give distress calls, depending on the species. This frightens the rest of the flock away from the area. In higher concentrations, this chemical is used as poison. The fifth major category of control techniques is "Removal" or "reduction". This is an attempt at direct population reduction by capture, egg control or killing. For any bird problem, this approach should only be used after other techniques have been considered and each rejected. As a general rule, direct

population reduction is not a good approach. Even if the safety man manages to remove a large proportion of the flock, other birds will eventually move in to replace them. It would be much more effective to permanently eliminate those factors that are attracting the birds or to exclude the birds from the area. Repulsion is preferable to population reduction because it is usually much easier to accomplish than trapping, and it is more acceptable to the public than poisoning or shooting the birds. Nevertheless, in situations where these other techniques are not appropriate, there are a number of capture and killing techniques that can be attempted. Many type of traps are commercially available to capture birds alive. Captured birds can be killed or transported and released a long distance from the air base. The manual includes plans for the construction of traps such as a pigeon trap, a nest box trap to capture Starlings or House Sparrows, and the modified Crow trap, which is actually used primarily for Starlings and Blackbirds or for House Sparrows. If the need arises, traps are also available for the capture of Hawks and Owls.

Killing of birds by poisons or other means should only be done as a last resort. But if all else fails, the poisons must be used. There are several chemicals available for use on Pigeons, House Sparrows and Starlings. When using poisons, the most important part of the programme is pre-baiting with untreated bait until all the pest birds are accustomed to taking the bait. There might be certain occasions when shooting the pest birds is an appropriate means of eliminating small number of birds in a limited area. The bait must be placed in locations where it won't be taken by protected species of birds.

Live ammunition is also useful as reinforcement for repulsion techniques, when killing an occasional individual will demonstrate the presence of real danger to the rest of the flock. But again, a permanent technique such as habitat modification or exclusion is preferable to repulsion or reduction.

Surveying a Bird Management Problem :

Before any problem can be solved, it must first be identified and evaluated. Periodic inspections of the entire airport should be performed to identify problems before they become too serious. The hand-out includes a checklist that can be used when conducting these inspec-

tions. The checklist will also help the safety man analyze the cause and circumstances of the problem and choose the most appropriate control technique.

Legal Restrictions :

Most birds are protected by national law and cannot be harassed, captured or killed without a permit. The only birds not protected by law are Pigeons, House Sparrows and Starlings. But even these species are also protected in some localities. Many control measures, such as scare tactics, trapping and the use of toxic chemicals require special permits. The safety man should check with the wild life authorities and local self Government. to determine what permits are necessary before using any control procedure.

In many circumstances control measures can only be taken with the cooperation of the environmental and wildlife service. The bird experts at district and regional offices of the Wildlife Service can provide much helpful information concerning birds and the control of bird problems. State conservation departments should also be consulted.

Bird Control and Public Relations.

Maintaining favourable public relations toward bird control programmes can be more difficult than solving the pest problem. The general public is quite concerned about humaneness toward animals, so attempts at lethal control of birds often make the news. The best way to maintain good public relations is to follow a sound approach to bird management and use the more social acceptable control techniques whenever possible. Each one of the five major categories to control techniques-Altering the concept, Altering the Situation, Exclusion, Repulsion and Reduction-is generally more socially acceptable than all the successive categories.

For example, if vultures in the vicinity of an airfield are creating a real problem, *Altering the Concept* is inappropriate. *Altering the Situation* by removing slaughter houses and bone collection farms away from the airfield approach areas and also by modernising them would be more acceptable to the public than would harassing the birds with loud noises in a *Repulsion* programme and there is no effective *Exclusion* technique for this situation, but *Repulsion* would certainly be more acceptable than killing the birds in any attempt at direct *Reduction*.

ELECTRICAL AND ELECTRONIC MEASURES TO REDUCE BIRD MENACE TO AIRCRAFTS*

WG. CDR. V. V. BHUPATI RAO

Introduction

The need for reducing bird menace to aircraft had already been amply highlighted. In the next few minutes, it shall be my endeavour, to discuss briefly, how electrical and electronic devices could contribute towards the fulfillment of this need.

Electrical and electronic devices have considerable potential in reducing the bird menace. A few of such devices could be :

- (a) High resolution radars
- (b) Bird scaring devices
- (c) Bird repellants
- (d) Controlled electrocution

High Resolution Radars

All aircraft have to fly low during the stages of take off and landing. In addition, military aircraft prefer to fly low, to evade detection by enemy radars.

If birds could be detected by radar, the air traffic controller, can delay the take-off or landing. He could even guide the pilot in avoiding the birds being tracked on the radar. However, it should be remembered that violent manoeuvres of aircraft will not be possible during the critical moments immediately preceding a landing or following a take-off. This is especially so in case of transport aircraft (like a Boeing or an Airbus) whose manoeuvrability is limited and any attempt or quick manoeuvres to avoid birds, will endanger the safety of the passenger not to speak of the aircraft. Combat aircraft have a better manoeuvrability.

*Paper was taken as read

In fact guidelines on flight safety, advise pilots of military aircraft to pull up, in order to avoid a bird strike.

Let us see what are the problems in detection of birds by conventional surveillance radars, operating in the lower frequency bands.

- (a) Safety of aircraft is endangered by birds, whose normal altitudes of flight are upto 1000 ft. But due to the gaps existing at low altitudes in the coverage of conventional radars, not even aircraft let alone birds can be detected by these radars.
- (b) Even if an object like aircraft is picked up in the vicinity of an airfield, it cannot be identified, against the stronger returns from ground reflections (known as ground clutter). Clutter from clouds, rain and snow can also adversely affect the probability of detection.
- (c) Birds, by virtue of their size, present smaller cross section to radars and consequently return weaker reflected signals, which cannot be detected by the conventional low frequency band radars.
- (d) Due to these inherent characteristics, surveillance radars operating in lower frequency bands have low resolution to the ability to distinguish two targets, separated radially or in azimuth by a small distance.

These limitations are overcome by specially designed radars, operating at higher frequency bands. Radars like AN/TRO 11 which operate at 35 GHz, can easily detect a single mosquito at a range greater than 2 km. At airports with high movement rates of aircraft in North America and Europe high frequency Airport Surface Surveillance Radars, operating at 16 GHz, 24 GHz and 35 GHz, have been in operation to assist Air Traffic Control Officers to monitor and control aircraft and vehicle movements on the surface of the airport. However, the application of these radars is limited, due to their extremely high costs and degradation in performance in rain, snow and blowing sand.

Airport Surface Surveillance radars operating at 9 GHz are now available, which are far more cost effective than the higher frequency radars just mentioned. These radars have very high resolution and can

distinguish two objects separated in range or azimuth by 9 m. at 1 km range. A man is clearly detected at 2 km, even when kneeling down. Flocks of birds and even individual birds can be detected at more than one km. Typical range is 8 km. The display is on TV monitors, with a synthetically superimposed map of the airfield. The system sensitivity and resolution are such that aircraft, other vehicles and potential obstacles can be seen in adverse weather conditions.

Bird Scaring Devices

Playing amplified pre-recorded bird distress calls have been effective in scaring away the birds from airfields. Audio visual simulation of threats to birds could also be tried. Such bird scaring devices could be deployed at suitable places in the vicinity of the airfield and activated remotely, coupled with observation of birds through powerful binoculars. There should be certain randomness and variety in such simulations, because, if the birds recognise pattern in the recordings being played, they may adapt themselves to such non-existent, artificial threats and ignore them.

Bird Repellants

All of us are aware of electronic devices emitting high frequency electromagnetic energy that irritates mosquitoes and drives them away. It may be possible to develop bird repellants, on lines similar to those of such mosquito repellants. I do not know if ornithologists are bird psychologists as well. But it would be pertinent to mention here the need for an indepth study of the psychology of vultures, pariah kites and other birds, to devise more effective means of reducing bird menace to aircraft. For example, a pariah kite is said to be deaf. It does not very often look horizontally and is always looking down for food. Therefore, despite the engine noise, the chances of a pariah kite striking aircraft are quite high. No audio device will be of any use in scaring away such birds.

Controlled Electrocutation

Prevention is better than cure. The best way to eliminate bird menace is to eliminate the birds. Royal Air Force did this very successfully in Gibraltar, in 1979-80, in collaboration with the Pest Infestation Control Laboratory of the Ministry of Agriculture, Fisheries and Food, and the local ornithologists. Baits of bread pieces impregnated with

measured doses of Seconal and Alpha Chloralose were placed on the eggs of the birds during nesting season. These doses caused drowsiness, incapacitation to fly and ultimately the death of the birds, in about two hours. The eggs were then broken and the nests were raked out. It was ensured that the drugs affected only the Mediterranean Herring Gull which was the menace to aircraft and no other bird or animal, even if it took it accidentally.

I feel that controlled electrocution can supplement the above method in a rapid yet painless killing of vultures and other big birds. A heap of carcasses can be covered by a grid of electric wires, carefully camouflaged and excited with appropriate separation from the carcasses. A fencing can be erected around the area to prevent accidental straying in of personnel or animals. The grid of wires is not normally energised. When considerable number of vultures gather, on the carcasses, the wires are remotely energised. Some of you may remember that Thomas Alva Edison, the inventor of the electric bulb, successfully employed this technique, to reduce the menace of rats in his laboratory.

REMOTE SENSING OF PROBLEM BIRDS IN AVIATION

BALDEV SAHAI*

Introduction

Birds and aircrafts have to share the same airspace. Unfortunately it is not possible to arrive at a suitable mechanism by which the right-of-way can be regulated. As a result frequent collisions between the birds and the aircrafts occur causing huge losses. It is reported that Air India and the Indian Airlines suffered a loss of Rs. 4.5 crores during 1981 alone, because of the birds striking the aircraft or the other way round. Minister of Civil Aviation reported in the Lok Sabha recently that between January 1981 and April 1982 there were 38 bird-strike accidents at the Palam Airport. The losses suffered by the Indian Air Force must be much more. There is a reason for the same. Practically the cruising height of the modern aircrafts is far above the level at which the majority of birds fly. The military aircrafts, on the other hand, usually fly at a lower level and so suffer more bird-strike accidents. The average for such accidents is fifty per cent near the air bases and fifty per cent away from them. In rare instances does a civilian aircraft get involved in such bird-strike accident away from an airport.

It is also fortuitous that inspite of thousands of bird-aircraft collisions every year all over the world, the number of fatal accidents is very few. The major fatal accidents during the last 25 years are the following.

1960: Electra Aircraft at Boston, U.S.A. with starlings (62 persons killed).

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1962 : Viscount Aircraft at Maryland U.S.A. with whistling swans (7 persons killed).

1962 : Dakota Aircraft at Lahore, Pakistan with vulture (Co-pilot killed).

Dozens of species are involved in birds aircraft collision. However, the problem birds are different in different regions and countries. Most of the north American and European airports have 'gulls' as the number one problem bird. In India 85 per cent of the accidents are attributed to vultures. The solution to the problem in India has thus to be devised keeping in view the Indian environment.

Various methods like playing of distress calls at airport to frighten away the birds etc. have been suggested to overcome this problem. However, as the species involved in India are widely different, this solution is not expected to show much promise. In this presentation, possible ways to detect the birds, their breeding grounds and monitoring the environment around the airports are being discussed. Remote sensing techniques can play a very useful role in this task. The expert opinion is quite definite that the long-term solution to the bird menace lies in making an airport environment inhospitable to birds by manipulation of the habitat in such a way that birds are no longer attracted to this environment.

The Problem

The birds frequent and use the airports for the following reasons (I.C.A.O. Service Manual, 1975) :

- a. in search for food,
- b. to find sites for nests,
- c. to seek shelter and safety
- d. to rest or to roost, and
- e. because the airport lies on migration route of certain species.

The edible garbage, earthworms, voles, lemmings, rabbits, insects, seed and grass growing in and around the airports provide source of food for many birds. Presence of slaughter houses in the vicinity of airports attracts vultures. The hangers, various buildings, trees or shrubs offer shelter and safety to the birds as well as serve as attractive sites for building nests. Certain birds nest in thick grass, weeds or

shrubs. The runway of the airports, particularly those which are not too busy, provide safety to birds as they have an unobstructed view of any predator and in coastal area, Gulls find the runway, particularly attractive for roosting during storms at sea (I.C.A.O. Service Manual, 1975).

Although migration of birds in large flocks is a serious problem in the Western world, this problem is not considered to be so serious in India.

The key factor to mitigate the bird hazards to aircrafts is through a sound environmental management, making the environment least attractive to the birds.

Before any meaningful action plans can be drawn up for environment management or for manipulation of the habitat we must have complete, reliable and up-to-date information on the current status of the airport environment. The information needs for same are (Blackpoel, 1976 and I.C.A.O. Service Manual, 1975):— (i) Geography, (ii) land use (particularly information on agriculture, waste disposal sites, slaughter houses, etc.) (iii) vegetation, (iv) soils, (v) hydrology, (vi) climate and (vii) birds and other fauna of the area.

In addition, the studies must cover the daily and seasonal variation in number of birds present, their species, habits and distribution etc.

An analysis of the above information can lead to the understanding of the problem : Why, how, where and when a particular bird species is present in the airport environment. We shall attempt to determine the role, the remote sensing techniques play in furnishing the information required to solve this problem. Remote sensing will hopefully provide enough information for planning remedial measures.

Remote Sensing

Remote sensing obviously implies sensing from a distance. It is generally understood to imply the acquisition of information about objects/phenomena by scientific means or devices called 'sensors' without bringing any physical contact between the object and the sensing device. We all are familiar with photography. It is a type of remote sensing (RS) technique. The camera is the sensor in this case. Let us examine our five natural senses sight, hearing, smell, taste and touch. The first three

can be compared to remote sensing. Eyes, ears and nose serve as the sensors of our remote visual, audio and chemical environment. In fact the phenomenon of 'seeing/recognition' of objects around us can provide a very close analogy with the modern RS systems. The eye is the sensor in this case for the electromagnetic radiation emanating from or reflected by an object. The brain serves as an ultra high-speed computer. It analyses the radiations making use of the stored information in the memory, which the RS specialists call 'signatures' and completes the recognition process.

The most widely used remote sensing techniques today are based on the detection/sensing of electromagnetic radiations and hence in its current connotation, 'Remote Sensing', refers to the sensing or detection of electromagnetic radiation which is reflected or emitted by an object. The remote sensing techniques are based essentially on the use of sensors capable of detecting and or measuring the reflected or emitted radiations.

Remote Sensing is not something entirely new although the term was coined only around 1960. One of the first and still an extremely important remote sensing technique, within the meaning of the term as currently understood and used, is aerial photography. First aerial photograph is reported to have been taken from a captive balloon in 1858 in a Paris suburb. Aerial photography has made rapid strides since then using aircrafts, helicopters and balloons (free flying as well as tethered). Photography itself has seen many developments. However, aerial photography has, by and large, remained confined to the visible part of the electromagnetic (*em*) spectrum which constitutes only a very small fraction of it. The remote sensing techniques have extended the scope of utilization of the *em* spectrum to almost its entire range. The interaction of non-visible electromagnetic radiations (e.g., infrared, microwaves) with matter is converted into interpretable information and thus human 'visibility' has been extended into the non-visible part of the *em* spectrum. Use of Remote sensing system is essentially meant for inventorying, mapping and monitoring of earth resources.

The major elements of such a system are following :

- a. Data Acquisition
- b. Data Processing and Analysis

Data acquisition process involves the following : (i) Energy source or

source of *em* radiation e.g., the Sun (ii) Propagation of radiation through the earth's atmosphere; (iii) Interaction of the radiation with matter, (iv) Sensors-active (e.g., radar) or passive; (v) Platforms-orbital, airborne sometimes ground based systems; (vi) Recording of sensor signals either in pictorial form or in numerical form electronically (e.g., on magnetic tapes) and (vii) Transmission of the data to ground-based stations. Data processing and analysis involves following :

(i) Conversion of electronic data into pictorial form or computer compatible tapes, (ii) Acquisition of 'ground truth' data comprising ancillary information and spectral signatures to serve as reference data. (iii) Interpretation of the data using interpretation devices, aids or computers in conjunction with the references data. (iv) Ground checks or evaluation of the data and generating information products for the users in the form of maps, tables, pictures and reports to aid them in their decision making process in the management of various earth resources.

A symposium (Thompson, 1975) on 'Remote Sensing Data in wildlife Management' held at Sioux Falls, South Dakota in October 1978 has highlighted the contribution which RS techniques can make in wildlife management.

We shall discuss those RS techniques here which can be optimally used for tackling the problem of birds as pest.

Remote Sensing Techniques

Aerial photography :— It is one of the earliest and still the most widely used remote sensing technique. However, the conventional aerial photography is generally based on the use of panchromatic black and white films. The interpretation of these photographs is based on the tonal variations, texture, pattern, shape, size, shadow, site or context. Most of the information needs of physical and spatial nature for environmental management can be extracted from such photographs.

In principle, it is possible to monitor not only the bird habitats but also carry out bird census through the aerial photography. The smallest bird that can be detected in an aerial photograph would depend upon the photographic system resolution. In a photographic system

with a lens of focal length f , flying at a height H above terrain, the scale factor is given by

$$S = \frac{f}{H} = \frac{d}{D}$$

If d is the smallest size object that can be distinguished in the image then the limiting ground resolution is

$$D = \frac{d}{S} = \frac{Hd}{f}$$

The factors limiting the resolution of an aerial photographic system are: (i) lens resolution, (ii) film resolution, (iii) film flatness in the image plane, (iv) type of aircraft and control of vibrations, roll, yaw and pitch, (v) contrast of the object and its surroundings, (vi) conditions of intervening atmosphere at the time of viewing and (vii) sun angle and viewing angle. Apparently estimation of limiting ground resolution is quite complex. However, to a good approximation, the limiting resolution is determined by the film resolution. This resolution is quoted in terms of linepairs per m (lpm). Assuming a lens of focal length $f = 100$ mm and the commercially available films with 80 lpm, the limiting resolution for an aircraft flying 1 km above the terrain is given by

$$D \text{ (mm)} = 10^6 \times \frac{1}{80} \times \frac{1}{100} = 125 \text{ mm}$$

It is thus possible to detect most of the problem birds which may be resting on the airport or in the vicinity and a census could be carried out.

Use of colour films may enhance the recognition of certain species.

Colour Infrared Photography:— During the world war-II black and white camouflage detection films were developed.

These films had spectral sensitivity extended into the near infrared region where the natural vegetation has typically 4-5 times higher reflectance than that in the green band. We associate greenness with vegetation because in the visible part of the spectrum, the green light is preferentially scattered or reflected by vegetation, absorbing light of other colours. In the post-war period, colour infrared (CIR) films were developed. CIR films have proved to be an excellent medium

of studying vegetation. All vegetation appears with different hues of red in the CIR films. Green objects (other than vegetation) appear blue and red objects appear green. Since the vegetation plays an extremely important role in the habitat, an aerial survey of the airport and the vicinity with CIR films can be very useful.

Television Cameras :

CCTV:— A closed circuit television (CCTV) system can be installed at critical places on the airport frequented by the birds with a monitor in the air traffic control (ATC) tower. This can enable issuing warning to the pilot approaching the airport. Television cameras are available with automatic lenses which control the light reaching the camera tube. Thus the system will automatically adjust for the varying light levels during the day. A CCTV system can also be installed in an aircraft for surveying the airport and its environs. However, such systems have to be quite rugged and can be operated only at the lower altitudes. At higher altitudes corona problem arises because of the voltages used. However, developments during the last ten years are offering very attractive solution in the form of CCD TV cameras.

Low light level television:— Quite a large number of birds may be present at the airport at night for which photographic or television observations are not possible. However, low light level television (LLTV) cameras are available which can record events easily in moonlight (typical flux 0.1 lux). One such system for example, comprises a single diode image intensifier tube which is fibre-optically coupled to a vidicon (Thomson, 1975) providing a gain of 50. By coupling two winged iode image intensifiers in cascade a light gain of more than 2500 is obtained providing starlight performance (10^{-3} lux). This can be coupled to a silicon intensified target (SIT) tube. At even lower light levels like overcast starlight, a microchannel image intensifier coupled to a vidicon or an intensified silicon intensified target (ISIT) may be used.

In all these cases improvement is obtained, because the response of the vidicon tube or its derivations (SIT, ISIT etc.) has been extended into the near infrared. It is possible in all these cases to instal the display unit in the ATC tower.

Charge coupled device-television : One of the developments during the last couple of years is the charge coupled device (CCD) television. CCDs are a new family of silicon semiconductor devices capable of performing general functions of imaging, (Hower, 1978) analog signal processing and digital or analog memory.

Fairchild has developed low light level, low-power consumption video camera system (CC AID 488) which is essentially an area imaging device (AID) having an area matrix of 488 x 380 sense elements capable of being electronically scanned in both X and Y axes to produce an area TV picture. The active area is 8.8 x 11.4 mm. It consumes 3.5 mA current at 10-15 V. It has 1000:1 dynamic light level range. It has thus dawn to dusk capability. Such cameras being extremely rugged, light weight and low power consuming can be used in aircrafts instead of the vidicon based cameras.

Such cameras have also been adapted for aircraft monitoring. A typical system based on CC AID 488 has been used as a view-finder in conjunction with aerial reconnaissance systems. It is 10 cm x 10 cm and is 23 cm long. It provides a low light level performance down to moon-light illumination conditions. It has variable focal length (zoom) optics. With a zoom lens of upto 50 mm (12-50 mm) focal length a variable field of view of 10° to 40° can be obtained. The ground resolution of 30 to 100 cm is obtainable, at 1 km altitude depending on the depression angle of the view finder lens (20°-90°).

The development of Time Delay and Integrator (TDI) CCD image sensor for low-light level imaging is another powerful tool available now. Fairchild has developed a 1028 x 128 element TDI. With such devices, pixels of the identical imagery are summed by clocking the charge synchronously with image motion across the along-track axis of the TDI array. With this device 128 integrations per integrating pixel column are effected increasing the signal-to-noise ratio.

Thermal Imaging :- Another technique for locating birds and or their roosts at night is the thermal, imaging. The birds will have a higher body temperature than their surroundings. A flock of birds roosting at a given spot will give a higher temperature for the same.

Temperature resolution of 0.1°C are achievable with the available systems. However, most of the systems are rather sophisticated and

bulky. Pyro electric vidicon Camera systems have been developed which provide a low cost low power consumption thermal imaging systems operating at normal ambient temperatures without any special cooling arrangement. These systems are portable and do not require skilled operators. The display can be directly effected by the conventional TV monitor.

Bray *et al.*, (1971) used an 11-channel multispectral scanner to obtain imagery of a 3-million black-bird starling roost in a mixed conifer hardwood area near Chapel Hill, Tennessee from a flying height of 460 m AGL with a ground resolution of 0.35 m. The trees with high concentration of birds showed higher temperature than the other trees.

Radar:- Radar-Radio Detection And Ranging-transmits high-powered radio pulses into the airspace in a particular direction, detects and displays the echoes that are returned on: say; a Plan Position Indicator (PPI). This gives the direction and range of the echo-producing target. Radars have been used extensively for studying bird flights and migration patterns (Williams *et al.*, —; Kanerd Tomas *et al.*, 1968; Estwood, 1967; Flock Warren 1974, Richardson, 1973. Estimation of the density of birds present in the airspace can be extremely helpful in routing aircrafts. These data can be used to guide aircraft around location where a bird strike is unusually probable. On a long term basis, the radar data can also be used to develop an operationally useful capability for bird-hazard forecasting particularly for migration season (Richardson, 1973). This estimation by ATC surveillance depends on (Blackpoel, 1976), on following: (i) Characteristics of the radar (peak power, sensitivity of receiver and of the antenna); (ii) Presentation of radar information (e.g., PPI, photography of PPI or time-lapse movie); (iii) The effect of radar 'fixes' (e.g., use of Moving target Indicator, MTI in modern radars to filter out echoes from mixed objective); (iv) The height distribution of the birds and (v) The need for permanent record of the presentation.

The type of radar also matters. The search or surveillance radar detects maximum number of targets aloft irrespective of the altitude and produces a fan-shaped beam. The tracking radar, on the other hand, produces a pencil beam of radar imagery, shows only those targets which fall into the narrow pencil beam and is able to detect and follow a single target, extracting maximum information about it. The measurable parameters (depending upon radar and target type) are (Richardson, 1978)

(i) number aloft; (ii) concentration areas; (iii) altitudes; (iv) flight directions and speeds; (v) approximate target sizes and (vi) wingbeat frequencies. Many of these parameters are measurable several kilometers away during day and night and sometimes above or even in clouds.

The identification of species presents quite a problem. Some studies correlate the bird size and the radar frequency. Thus multifrequency radar installations can be used for species identification (mainly through size) to some extent. The single-frequency reconnaissance radar is not capable of identifying a bird species uniquely. Though any S—and L—Band surveillance radar can provide real time information about the number and location of birds in the airspace (Richardson, 1973). Flock and Green (1974) have studied the amplitude and Doppler signature of birds and their spectra. Amplitude signature is amplitude modulation at the wingbeat frequency which varies inversely with the size of the bird. The Doppler signature is obtained through the use of a coherent (Doppler) radar analysing the Doppler frequency spectrum of the echo from a bird. Doppler shift of echoes providing a direct measure of radial speed and enhanced ability to detect weak moving echoes (Richardson, 1978). Pulsed-Doppler radars can reveal range as well as bearing, speed and both Doppler and amplitude signatures.

Land Use In Airport Environment

Habitat manipulation for mitigation of the bird strike problem depends on resorting to a suitable land use. Guidelines for the proper land use around the Canadian airport (Blackpoel, 1976) divides an airport into three zones A, B and C with radii of 3.2 km, 4.8 km and 8 km respectively. For large international airports all the three radii are to be increased by 1.6 km. The incompatible land uses i.e., uses which increase the birdstrike hazard within each zone are given in Table-1.

Table-1 Incompatible Land Uses In Airport Environment

Zone	Incompatible Land Use
A: (3.2/4.8 km)	Picnic and camping areas Power lines and electrical plants Flat-roofed buildings with inadequate drainage or those designed to hold water on roof.

Zone	Incompatible Land Use
B: (4.8/6.4 km)	Forest reserves Fish reserves Sod (turf) farming Seed farming Crop farming Race tracks Food processing plants where edible wastes are accessible to birds 'Drive-in burger' and food service stands where food is consumed in automobiles and remains are disposed of in open garbage containers.
C: (8/9 km)	Bird sanctuaries Swamps Flood and flood control areas Game preserves Piggeries Fruit-tree farming Stock feedlots Stockyards (with pens, stables, etc) Fire grounds Outdoor theaters Water storage (open) Raw sewage outfalls Garbage dumps Sewage lagoons Sanitary landfills

As far as India is concerned, vultures and pariah kites have proved to be the biggest nuisance in bird-strike problem. Presence of slaughter houses within a 10 km radius should not be allowed so as to discourage the presence of vultures in the vicinity of the airport. Other incompatible land uses, not listed in Table-1, are fish markets, meat market, tannery etc., around the periphery of the airports.

Remote sensing techniques can be easily exploited to monitor a 10-km zone around an airport. It is possible to detect and locate any of the undesirable land use features listed above. The need for monitoring arises because even temporary violation of these guidelines can play havoc with movement of the aircrafts vis-a-vis birds.

One of the biggest problem in India is that often the airport area is outside the jurisdiction of local Municipal Corporation and so the Corporation authorities are unable to offer any assistance. The Pan-chayats lack infra structure to regulate proper land use in the vicinity of the airport. Thus this problem must be looked into.

Some Suggestions For Tackling The Problem In India

- (i) Arrange a comprehensive land use survey of a 10-km radius zone around the main airports complex. The scale of aerial photography can be 1:10,000 or 1:5,000, if possible. Since vegetation plays an extremely important role, colour infrared film should also be used. This should be supplemented by collection of other ground-based data to have a complete ecological survey.
- (ii) The above data should be used in detecting incompatible land uses, preparing bird distribution maps etc. It should lay special emphasis on locating ditches, open waterbodies, tall trees etc. Incompatible land use features must be removed.
- (iii) Indian Airlines should consider installing 70-mm format photographic camera and a CCD TV alongwith a video tape recorder in one of the Boeings. The schedule of this aircraft should be so arranged that it will be visiting atleast once a month all the airports which have a serious bird strike problem. These two sensors should be activated when the aircraft is within a distance of 10 km from the airport during the landing and the take off phase. Both possible approaches to the runway should be covered.
- (iv) The photographic and video-tape data should be studied for incompatible land use and for information needed for habitat manipulation.
- (v) Director General Civil Aviation, the Ministry of Defence and the Indian Airlines may look into the modalities of aerial photography from various angles.
- (vi) One safety officer at each airport may be given suitable training for the interpretation of the imagery.

- (vii) Use of radar for detecting birds should be encouraged so that pilot be warned. Similarly critical areas on the airport could be monitored through CC TV from the control tower.
- (viii) Legislation should be enacted to authorize DGCA to take appropriate measures against any land use which is conducive to attracting birds to the airport environment.

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REFERENCES

- Blockpoel, H, 1976. Bird hazards to Aircraft, Clarke, Irwin and Co., Toronto, pp.
- ICAO 1975-International Civil Aviation Organization, Airport Services Manual, Part 3, Bird Control Reduction, 58 p.
- Berger Michael E. (Ed.), 1978 Proc. Pecora TV Symposium on "Applications of Remote Sensing Data to Wildlife Management", Sious Falls, S.Bakota, October 10-12, 1978, National Wildlife Federation, Washington DC. 397 p.
- Thomson, E. C., 1975. Developments in Low Light Level Television, in Proc. Int. Conference on "Low Light and Thermal Imaging Systems", March 3-5, 1975, Institute of Electrical and Electronics Engineers (IEEE) Conf. Publication No. 124, pp. 139-162.
- Bower, F.H. (1978). CCD Fundamentals, Military Electronics/Counter-measures, February 1978.
- Bary, O.E., E.C. Knittle, J.R. Jack and Robert-L. Bowman, 1978 'Location and Identifying Black Bird Roosts by Multispectral Remote Sensing', In Thomson, E.C., 1975. pp. 194-196.
- Richardson, W. John, 1978, "Radar Techniques for Wildlife Studies" pp. 171-179, In Thomson, E.C., 1975.
- Williams, T.C., J.M. Williams, J.M. Teal and J.W. Kanwisher Tracking year Radar Studies on Bird Migration in "Animal Orientation and Navigation". NASA SP-262 pp. 115-128.

Konard, Tomas G., John J. Hicks, Ella B. Dobson, 1968). Science 145: 274.

Estwood, A., Radar Ornithology, Mathuen, London 1967 (quoted in Blackpoel, 1976).

Flock, Warren L. and John L. Green, 1974, Proc. IEEE 62: 745.

Richardson, W. John, 1973. Radar Angels, in Letters to the Editor, Aviation Week and Space Technology, November 26, 1973.

FLYING HABITS OF BIRDS AS RELATED TO WEATHER

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Meteorological factors like winds and temperature to a large extent determine the flying habits of birds. In this paper, meteorological conditions which are conducive for soaring for birds are discussed.

Flying aircraft as well as birds use the medium of air. The purpose of this seminar is to investigate the flying habits of the birds which interfere with aircraft flying and occasionally results in flying accidents. Since aircraft and birds use air as the medium, it will be advantageous to direct our studies on the meteorological factor which help or deter the flying activities of birds. At the very outset, I would like to say that such study of Meteorological factors has not been made in great detail in this country. While studying bird habits and taking measures to reduce bird hits on aircraft, it is necessary to study Meteorological factors as well.

A certain amount of concerted study on flying habits of locust has been done with a view to control its menace. In 1963, a seminar was held at Tehran where meteorological factors associated with migration of locusts over thousands of kilometres, over land as well as sea were clearly laid down. The breeding ground of locusts is the desert regions of Saudi Arabia and Somalia. These locusts are noticed to travel as far as India and further north to China as well. It was a puzzle before this study, how locust could travel thousands of kilometres over desert, across Arabian Sea and move into Rajasthan and adjoining North West India. The study revealed that locust move down with the wind, namely South Westerlies and enter our country. In this connection those who are

*Paper was taken as read.

interested in knowing about locust movements and meteorological factors associated with it in greater details may refer to WMO Technical Note No. 69 (Meteorology and Desert Locusts). For the sake of interest and to motivate distinguished scientists assembled here into meteorological factors associated with birds movement, I will say a few important factors connected with locusts.

The locusts are observed to fly from nearer to ground to a height of 304.8 meters or more depending upon the thermals. They make use of prevalent winds to move usually down wind. Even though they use their own energy for flights, they get a large amount of 'tail component' and hence cover greater distances than what could have been possible if there is no wind at all. The observed locusts in this country migrate with the South-Westerly stream for migration from desert region of Saudi Arabia. Further they require certain optimum temperature conditions to prevail for flight. For locusts to fly, its body temperature should be about 20°C. Consequently they do not undertake flight at night time when the environment is relatively cool. They wait for the day when the temperature is higher and surface winds and winds in the atmosphere near the surface turbulent, strong and have thermals. In short, the flight of locust is to a very large extent controlled by meteorological factors of winds and temperature.

In the early 1950s Prime Minister Pandit Jawahar Lal Nehru visited the Delhi Zoo and saw lions and other wild animals kept within cages. He remarked that these animals roam around in their natural habitat and in the zoo they must be suffering because of being confined within cages. J. B. S. Haldane, the noted British scientist who chose to settle down in this country, posed the question "Are these wild animals unhappy to be confined to the limited space available in zoo?" He quoted an experiment saying that animals do not roam around for the pleasure of it. They move only in search of food. If the food is available, they will not undertake long trips. What he remarked about animals is appropriate in case of birds also. Their movement is in search of (a) food and (b) habitat conducive for living. In the case of birds like kites and vultures the meteorological factors that enable them to move in search of food are noteworthy. These birds do not like spending their own body energy for flying. They would like to make use of atmospheric conditions to gain height from where they can have a survey of the land

where their food will be available. It is these types of birds which soar high into the atmosphere, that cause a greater risk for flying aircraft.

Now I would like to enumerate a few atmospheric conditions which enable birds to soar fairly high into the atmosphere. Thermals are up currents due to two factors (a) Orography (b) Buoyancy. On any clear day when there is good amount of sunshine, one can clearly see birds like vultures and kites soaring high into the atmosphere. The thermals due to buoyancy are caused by heterogenous heating of land-mass by sun's radiation. Usually thermals are short lived and are very small in horizontal extent. Nevertheless, they frequently get formed and after a short duration decay. These birds seek the thermals for soaring and when once the thermal decays they seek the next one where it is possible to continue their flights. During a clear day with bright sunshine there is no dearth of such thermals and vultures and kites are air-borne throughout the day.

The thermals due to orography are also important. They are caused by small hillocks, sometimes big buildings, peaks of mountains etc. As the air flows across the barrier, rises on the wind-ward side and goes down on the lee-ward side. Due to certain meteorological factors which I would not like to go into details, it is possible to have standing waves. On the leeward side of obstacle there will be upcurrent in the next portion of the wave and down current in the next portion. I had watched soaring birds often making use of such up-currents caused by orographic factors. During the day time the protruding prominences like big buildings, tops of hillocks, peaks of mountains provide more or less a semi-permanent source of thermals due to heating. Even when the atmosphere is relatively calm, soaring birds are in the habit of making use of them. In this connection my own personal observations of birds over Chitra Palace and Fort in Jodhpur as well as the hillock at Trichy, bear out the above mentioned points.

Now I will give two more meteorological factors which I have noted in Delhi, which are used by soaring birds. Before the 'Andhi' (dust/thunder storm), a swarm of soaring birds are noted to ride the gust front. For the sake of making the idea clear, I would like to say that the direction of wind suddenly changes, say by 180 degrees, at onset of duststorm and the atmosphere is characterised by a large

amount of vertical upward motion. Normally, citizens of Delhi take shelter against the onslaught of duststorm or 'Andhi', where as these soaring birds appear to be happy to gain further height.

In winter when Delhi and surrounding areas are fogbound, and it looks as if the fog is not going to lift up, as a casual observer on ground, I have noted that the vultures and kites go up in the air the moment the dissipation of fog takes place. As a matter of fact, I have used this observation of soaring birds as a sure sign of forecasting the immediate dissipation of fog itself.

During hot day I have observed soaring birds numbering 50 or more just sitting on the lawns of Rajpath where it is relatively cooler, instead of soaring into the sky. These are the days when temperatures are in excess of 45°C. Even when wind conditions are favourable for soaring, my observation is that these birds do not take to sky, most probably because of very high temperatures.

We are confronted with a situation where flying birds and aircraft flying do not harmonise especially in the context of faster moving low altitude flying of civil and military aircrafts. The menace of birds so far as aircraft flying is concerned is on the increase. Probably birds may say that the aircrafts are a menace to them. It is not practicable to eliminate all birds and make the atmosphere free from birds to ensure cent percent flying safety to the aircraft. It is possible to minimise this menace if we know the habits of birds. Meteorological conditions to a large extent determine the habits of birds. Especially winds and temperatures play a dominant role in the habits of soaring birds. A detailed study of meteorological conditions associated with birds movement and soaring has not been done in this country. I may appeal to the distinguished scientists to take atmospheric factors in their studies as well.

BIRD HAZARD TO AVIATION

WG. CDR. N. K. JHA

ABSTRACT

Bird hits cause losses worth crores of Rupees to Aviation every year. The Indian Civil and Military Aviation suffer a loss of about Rs. 15 to 20 crores a year due to bird hits alone.

The year wise bird hit figures for the airlines are as follows:—

1970 (20)
1971 (17)
1972 (43)
1974 (36)
1975 (65)
1976 (76)
1977 (86)
1978 (103)
1979 (112)

During take off, landing and low altitude flying some times birds flying in the vicinity of the aircraft intakes are sucked in, resulting in an extensive damage to the aero engine. The damage to the compressor rotor blades and the extent of secondary damage to other stationary and rotating components depends on the weight and size of the birds.

Birds around airfield are a great hazard to flight safety. Every year civil and military aircraft suffer heavy losses due to bird hits. Thus this problem assumes the magnitude of National importance. Birds mainly vultures are attracted on the garbage, and food waste, dead animals/carcasses, etc. The first essential requirement to combat bird

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menace is to bring about a general awareness amongst the people. Once the people are educated, it will invoke a greater response from them in maintaining better environments around Airfields.

To mitigate the problem of bird hazards, the following steps are desirable :—

- (a) To have an Airfield Environment Management Committee to study the basic problems of bird hazard, suggest means and take appropriate action.
- (b) Special bird studies to be carried out on selected airfields.
- (c) Effective bird population control measure around airfield area.
- (d) Use of bird scaring cartridges.
- (e) Study regarding the types of bird and their frequency and characteristics in India.
- (f) Issue of bird warning.

Birds around an Airfield are great hazards to flight safety. As such their population must be controlled. It is necessary to have a proper Airfield environment which does not attract birds. Proper functioning of Airfield Environment Management Committee will go a long way in mitigating the bird menace around an Airfield area.

ECOLOGICAL STRATEGIES REDUCING BIRD HAZARDS TO AIRCRAFT*

K. J. JOSEPH**

ABSTRACT

Collisions between birds and aircrafts have assumed great importance in recent years. It has become a matter of great concern both for the Indian Air Force and the Indian Airlines. On the Indian sub-continent, three species of vultures, the Common Kite, and the Short-toed Eagle have been recorded to have caused the maximum number of strikes. The various aspects of bird behaviour tending to promote collision with aircraft, are discussed. If the number of birds frequenting our airfields and their environs is reduced the number of bird strikes will also diminish. The ultimate answer is to make our airfields and their surrounding repulsive to birds by appropriate modifications of their habitats.

Although we can profit from the experience of some of the advanced countries in the methods used for preventing or reducing bird strikes on aircraft, the methods we employ should be based on studies made under Indian conditions. It is necessary to take up serious studies on this problem of bird-aircraft collisions in all its aspects under the direction of an Associate Committee of experts drawn from the Indian Air Force, the Indian Airlines, the Directorate General of Civil Aviation (India), the International Airport Authority of India, the Department of Aeronautical Engineering of the Indian Institute of Science, Bangalore, and from avian ecologists of Indian Universities and other institution like the Bombay Natural History Society.

*Full paper was not received. Abstract was taken as read—Editors

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SUGGESTION FOR CULTIVATION OF 'AK' SHRUBS AROUND AIRPORTS-TO REDUCE CONCENTRATION OF INSECTS AND BIRDS*

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Introduction

The BASH (Bird Aircraft Strike Hazard) has now become a well known phenomenon in aviation all over the world, causing damage to aircrafts but also affecting loss in revenues. At times, the lives of several air-passeers are at stake while resorting to emergency landing after the BASH. The losses have increased manifold after the advent of Turbo-jets and training aircrafts. It has been estimated that around Rs. 20 crores are lost every year by this menace. If this colossal loss and menace is continued year after year with slight increase per year a tremendous loss may result. This is supported by the figures of aircraft being hit from 1977 to 1980, i.e., 20, 130, 149 hits, respectively. According to Ex Civil Aviation Minister Mr. A. P. Sharma there were 38 bird strikes incidents between January 1981 and April 1982 of which 10 were due to vulture hits. The worst bird hit prone airports are reported to be Bombay, Calcutta, Madras Delhi and Agra. The air force planes are most vulnerable to this problem as their sorties are undertaken at low altitudes where as civilian aircraft cruise at higher altitudes and face the risk while landing or taking off only. While studying this problem, it has been observed that BASH is mostly linked to few problem birds viz., scavenging or with birds predated upon insects. Several other BASH problems like timings of aircraft arrival is related with meal timings of birds. Considering this most important aspect of bird habit, a suggestion is given below which may, to some extent reduce this menace from threshold level to limit of toleration.

What attracts birds in and around airports

The most important parameters are : (1) Birds seeking food refuge,

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*Paper was taken as read.

either connected with human food or animal food. (2) Predatory birds seeking insects, either around airport or from the pests available in cultivated fields contiguous with airports. (3) Thermal liking of birds, caused by coming and going of aircrafts and the warm smoke jetting out of aircrafts which creates rising current of warm air formed near runways where in the warmer air the birds relax and love to float. (4) Availability of large number of ponds attracting migratory birds around airports. (5) Nature and availability of cover/shelter for roosting of birds and breeding purpose and (6) Nature and type of soil terrain around airports whether coarse fine or rocky. This effects birds landing.

Number and type of birds around airports

Ornithologists have listed around five dozen different types of birds involved in BASH in areas around and the vicinity airports apart from the bird available enroute. These can be easily differentiated in two major groups, and are :

1. *Bigger and heavier birds* : These include Bengal and white Scavenger vultures, pariah kites, cranes and peacocks etc. They often cause serious damage to aircrafts. Some of these birds are attracted towards dead cattles and waste dumps.
2. *Smaller, lighter insectivorous and seed eating birds* : These include crows, sparrows, parrots, pigeons and doves etc. which cause lesser damage. They feed mostly on insects and seeds available around airports.

Manipulations in preferred habitats, parameters affecting congregations of birds in areas, in and around airports would reduce 'BASH' problems. In this regard, of various factors, insect population increase after post monsoon period deserves attention. It indicates significant increase. Thus there appears to be positive correlation between increased population which normally attracts more bird population resulting in more 'bird hits' viz., during October. Therefore, study of physical environment of airport and the parameters which affect/attract birds is necessary. However, integrated approach is also necessary.

According to Ex Minister of Civil Aviation "the Government had taken various steps to prevent the occurrence of such incidents around airports by regular cutting of the grass on the shoulders of the runway

and clearing of shrubs". Other steps include spraying of insecticides and diesel emulsion on both sides of runways and taxiways at regular intervals, regular sweeping of runways and taxiways for any dead insects and other materials attracting birds (the force or air pressure while landing or take off is not enough to sweep off such dead material).

Physical Environment around airports

Most of the airports for saey reasons are located outside the municipal limits and are almost surrounded by cultivated fields and wild plants which harbours grain, seeds, rats and insects which are relished by birds. This local situation is unavoidable and birds, large or small for various reasons are attracted there.

It is therefore, desirable to have atleast such plantation around airport which is deterrent to both insects and birds and the most suitable plant famous, in Botanical literature is common 'AK' plant (*Calotropis* sp.). This plant harbours only one insect, commonly known as 'AK' grasshopper, *Poecilocus pictus* (Fabr.). Why the stress is given for plantation of this plant around airports can be understood from the brief history of the plant and the insect it harbours, as mentioned below:

Nature and content of 'AK' Plant :

Three species of the plant occur in India and two of them *Calotropis gigantea* and *C. procera* are also of economic importance. Both species resemble each other and have similar uses. The plant yields latex and contain a cardiac poison. The bark yields strong fibre superior to cotton in tensile strength. The floating seeds are dispersed through air and often used for stuffing pillows. The plant is a shrub of 8-10 feet high with stem containing milky juice. Latex yields nitrogen and sulphur containing cardiac, fish poison and few enzyme similar to papain (Ganpati and Sastri, 1936). The flower contains a long chain of fatty acids and alcohol (Murti and Seshadri, 1945). Ash of *C. gigantea* is rich in potash (20.8%). The wood yields a light charcoal which is used in gun powder and fire works. The latex is a strong irritant to skin and mucous-membrane. An extract injected into the lymph sac of a frog caused slowing of heart and acute gastro enteritis (Sharma, 1934). The stem, root bark, flowers, and leaves are used in medicine. In cases of *Calotropis* poisoning, demulcent and mucilaginous drinks, milk and rice gruel etc. should be given and morphine, atropine administered to allay pain. On the other hand *C. procera* commonly called as 'Akada' is also

a shrub 6-8 feet high. The latex of this plant contains trypsin an active labenzyme and a heart poison. The leaves and stem contain calotropin and calotropagenin. In all other properties it is similar to *C. gigantea*. The *C. procera* is often found as a weed in Agricultural lands. It can be controlled by spraying 0.3% solution of 2-4 dichlorophenylacetic acid.

Peculiarity of the insect harboured by *Calotropis* spp.

Only one species *Poecilocus pictus* (Fabr.) pass its development on these plants. A single annual generation is a rule for this species, except in South India where according to Fletcher (1914) there are probably two broods each year. However, the species is variable in respect of different life stages. Northern India, oviposition occurs during monsoon season (June-september). The eggs undergo diapause, in winter and hatching occurs during March-April. Thus adult life is restricted to only 4 months on the plant and the hopper period for 2 months. In between these periods the plant does not harbour any insect. No other insect attacks this plant. Development from hatching to adult takes 55-60 days. Eggs remain buried (diapause) in soil for 5 months. However, as recorded there is no diapause at egg stage in South Indian race and hatching occurs about one month after oviposition and nymphal instars take 73-77 days to become adults. The number of eggs per pod ranged between 60-140 (Average : 116). Females respond to mating after 3-5 days of the last moulting (Raziuddin *et al.*, 1977) and oviposition starts after 25-30 days after the final moult. Increase in density enhances mating percentage and copulation can occur more than once.

The most important features of *Poecilocus* spp. is that they have well developed defence mechanism with a degree of colouration and behaviour pattern. The colouration is more aposomatic than cryptic. In *P. pictus* it is bright yellow mixed with blue striped pattern. There is no attempt at "warning" displays nor any attempt at concealment. The most important aspect in the species is its efficient repugnatorial mechanism. This consists of an adominal gland situated below the first abdominal tergum and having its outlet through the membrane between first and second terga which can emit jet of toxic fluid containing "histamine" and digitalis like toxins (Pruthi and Nigam, 1939, Qureshi *et al.*, 1969 and Qureshi and Ahmad, 1970). The squirting of the fluid is best developed in nymphs which can throw it upto 50 cm.

According to Euw *et al.* (1967) fluid mechanism, apart from the initial startling result of ejection, it adds to the overall aposematic effect, the fluid has further defensive properties through its repugnant odour which gives an acrid burning sensation it produces in the mouth of birds, reptiles and mammals, due to the toxic effect of the cardenoides and the histamine contained in the fluid.

The value of defence mechanism is enhanced by grouping observed in adults and especially by the nymphs. Since the fluid contains a sex pheromone, it has thus an additional function of attracting two sexes (Chopard, 1938).

Discussion and conclusions

Since the factors for bird visitation around airport has now been identified, the major task remains is how to create an 'anti bird dome' around airport, by physically improving the environment which is unattractive and deterrent to birds. The scientific management of the environment can be best conceived through plantation of 'AK' shrubs (*Calotropis* sp.), which harbour only one species of insect that too by its internal anatomy and physiology have proved repellant to birds and lizards. Because of their impalatability these grasshoppers are largely immune from the attack of higher vertebrate predators such as birds (Gentry, 1965) and lizards (Pradhan, *et al.*, 1975). The higher population of this insect as and when encountered can be biologically controlled by predaceous insects like *Mantis religiosa* (L) or parasitic flies like *Blaesoxipha kaestneri* Bar. (Pandian and Delvi, 1975). Similarly the spread of 'AK' (plant can be easily tackled as mentioned elsewhere). The insect itself is virtually or completely flightless and if the habitat conditions remain favourable, there is little tendency to leave the confines of the habitat.

From the studies made from its life cycle it is clear that the adult of the nymph are available on the plant between March/April to September only. In the remaining months, October to March there are adult and nymph stages.

In conclusion it is suggested that a trial be undertaken at some airport in India for evaluating this suggestion.

REFERENCES

1. Chopard, L. 1938. La biologie des Orthopteres—*Encycl. ent.*, (A) 20 pp. 11+541, 5 pls.
2. Euw, J. Van, Fishelson, L., Parsons, J. A., Reichstein, T., and Rothschild, M. 1967. Cardenolides (heart poison) in a grass feeding on milk-weeds.—*Nature*, London, **214**, 35-39.
3. Fletcher T. B. 1914. Some South Indian insects and other animal of importance considered especially from an economic point of view. Xiii+565 pp., 50 pls. Madras (Publ. Govt. Press).
4. Ganpati and Sastri, 1936.—*Proc. Indian Acad. Sci.* **13**. 44.
5. Fentry, J. W. 1965. Crop insects of North east Africa South west Asia —*Agric. Handb. U. S. Dept. Agri.*, No. 273, 210 pp.
6. Murti, P. B. R. and Seshadri, T. R. 1945. Chemical composition of *Calotropis gigantea* Part VI Flowers, A comparison of the Composition of various parts of the plant.—*Proc. Indian Acad. Sci.*, **22A**; 304-309.
7. Pandian, T. J. and Delvi, M. R. 1975. Observation on the mortality of the grasshopper, *Poecilocus pictus* (Fab.) infected by Sarcophagous parasite, *Blaesoxipha Kaestneri*.—*Indian J. Ent.*, **35** (1973); 50-52.
8. Pradhan, S., Singh, K. M., Sangwan, H. S., Singh, R. N. and Singh, R. P. 1975. Exploration of vertebrate predators for crop pests 1. Food and feeding habits of spinytailed lizard, *Uromastix* sp.—*Indian J. Ent.*, **35** : (1973), 148-199.
10. Qureshi, S. A. and Ahmad, I. 1970. Studies on the the functional anatomy and histology of the repellent gland of *Poecilocus pictus* (E) (Orthoptera : Pyrgomorphidae) : *Proc. R. ent. Soc. Lond. London.* (A) **45**: 149-155.
11. Qureshi, S. A., Wahid, M. A. Mohiuddin, S. and Rizvi, K. L. 1969. Pharmacology, chemistry and behaviour of the repellent fluid of poisonous grasshopper (*Poecilocus pictus* (Fabricius) (Pyrgomorphidae, Acridoidea, Orthoptera).—*Pakist J. Biochem.*, **2** : 50-54.

12. Raziuddin, M., Khan, T. R. and Singh, S. B. 1977. Observation on the sexual behaviour and oviposition in the female grasshopper *Poekilocerus pictus* Febr. Acridoidea, Pyrgomorphidae). *Zool. Anz.*, 198: 63-67.
13. Sharma, G. K. 1934. *Calotropis procera* and *C. gigantea*. *Indian J. Vet. Sci. and Anim. Husb.*

ECO-BIO MANAGEMENT TO CONTROL NUISANCE OF BIRDS AT AERODROMES

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Birds-hits to commercial and military (Aircrafts) is a serious menace. It is increasing particularly in India because largely birds are protected with religious sentiments. It is causing loss of crores of rupees per year to the Indian Airlines and Indian Airforce as 462 birds-hits to aeroplanes were reported in four years (1978-1981) in India (Hindustan Times, 1982). Ecological studies and reports on this problem in India are not available. Various press reports reveal that Common vulture & kites and some other birds like the pigeon are some of the birds involved in BASH. Eco-biological aspects of bird-hit problem around Jodhpur Aerodrome were studied for two years from January, 1980 to March, 1982.

Methodology :

Eco-biological aspects of movements of birds particularly the common vulture, house crow, Pariah kite and the pigeon in and around Jodhpur aerodrome were observed particularly in reference to usual take off and landing paths of aircrafts. Human factors responsible for higher populations of nuisance birds around the aerodrome were also observed.

Observations and Results

Garbage Dumps and Nuisance of Birds

There is a large colony as Sansi tribe people adjoining the aerodrome they dump garbage of their houses in adjoining wasteland and surprisingly the Jodhpur-municipal Sanitation Unit also dumps garbage thereby, including carcasses of dead livestock of Jodhpur city in sewerage

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nullah following by. All that attract house crows (*Corvus splendens*), Scavenger vulture (*Neophron percnopterus*) and the Common vulture (*Gyps bengalensis*). Both vultures have habits to soar at usual feeding haunts to locate carcasses there that endanger low flying aircrafts. Similarly there is dumping of municipal garbage at the south west side of the aerodrome attracting vultures there close to the major landing and take-off air-strip.

Dumping of garbage and carcasses by the residents of isolated hut colonies and the Sanitation Unit of the Municipal Council should be strictly prohibited and checked around 3 km outskirt area of the aerodrome and 5 km extension areas, both from terminus of landing and take off air-strips. This can be done smoothly and efficiently with local Environment and Aircraft Safety Management Committee, comprising Municipal Chairman, District Collector, Ornitho-ecologist and social heads of nearby localities. There should be ready convenience to dispose away carcasses of dead livestock of nearby localities.

Sewerage Water Accumulation Around Aerodrome

Large amount of sewerage water of the city particularly of industries accumulate at the west and east sides of the Jodhpur aerodrome developing a large sewerage-pool there. The pool attracts considerable number of water birds e.g. the Blackwinged stilt (*Himantopus himantopus*), egrets (*Egretta garzetta*) and *Bubulcus ibis*, Sandpipers (*Tringa* spp), Little stint (*Caladris minutus*) and the Redwattled lapwing (*Vanellus indicus*) etc., flying of these birds there is serious hazard to low flying helicopters as well as landing and taking off aeroplanes.

No sewerage-pool development should be allowed there instead with properly managed channels sewerage be diverted to distant dispersal grounds.

Restaurants and Meat Shops

Considerable number of restaurants exist at the bus-terminus and corners colonies so also there are some meat-shops. Kitchen scrapes and leftovers of restaurants and scrapes from meat-shops attract large number of birds particularly the Pariah kite (*Milvus migrans*) and the house crow. They constantly hover around the aerodrome in search of offals and prove hazardous to low flying helicopters, gliders, landing and 'taking-off' aircrafts.

Restaurant managers and meat sellers should be instructed not to throw their scrapes and offals out of their shops, these should be kept covered and should be lifted away by municipal garbage carriers.

Pigeon Nuisance

In northern India, particularly in Jodhpur region, religious people daily feed foodgrains to the pigeon early in the morning and also give protection, hence populations of birds are very high around Jodhpur so also around the aerodrome which is now within urban periphery. The pigeon has habit to live in and at houses, perching at whatever projections and clefts are available there. On 'bang' or production of loud noise pigeons of vicinity take off, their flying flocks endanger low flying aircraft particularly helicopter.

Discouraging feeding of the pigeon nearby the aerodrome and eliminating or providing steep slope at projections on clefts in houses and buildings around the aerodrome may considerably reduce menace of the pigeon for want of facility to rest, roost and breed.

Scrub and Grass around Airstrips and Nuisance of Birds

Grassland attracts flocks of larks during the winter (migratory birds), noise of taking-off planes, disturb these & leads them fly. These may there hit the aircraft or get sucked in engines. Similarly scrub attract several species of birds particularly babblers (*Turdoides* spp.) doves (*Streptopelia* spp.), bulbuls (*Pycnonotus* spp.) and the Rosy Pastor (*Sturnus roseus*), these may similarly prove dangerous to taking off aircrafts. Birds of prey (*Falco* spp.) also soar much at scrubs for preys e.g., small birds and rodents and endanger low flying aircrafts. Hence it is purposeful that no grass scrub is allowed to grow around airstrips, atleast upto 500 meters, both sides.

Avoidance of Optimum Timings and Route of Birds

It was observed that house crow, Rose-ringed parakeet (*Pesittacula krameri*), house sparrow and several other birds go to distance countryside or villages in early morning about sunrise and return to roost in city area around sunset; during these flights, hundreds of birds fly over the aerodrome enroute and may prove serious hazard to landing and taking off aircrafts.

It is better to avoid taking off and landing of aeroplanes during that optimum period, 10 minutes to 30 minutes past sunrise and 30 minutes to 10 minutes past sunset. Slow flight of aeroplanes give sufficient advance signal to birds to escape hit. It was noted that birds try to remain away from slow flying aircrafts. Secondly, parabola take-off and landing of the aeroplanes can minimise coming across the birds which largely fly at low heights.

Discussions

Vohra (1982) mentioned practices of amplified screech of the Falcon, bangof cracker and shooting of birds at aerodromes of European countries to scare away birds from aerodromes. According to my observations repetitions of such screams without appearance and danger of the falcons may soon make birds fearless and unwary of such alarm sounds. It was noted that birds around aerodromes are somewhat negligent to usual roar of low flying aircrafts as get habituated. Quaterly spraying of grasslands with insecticides around airstrips (Vohra, 1982) is not sufficient to reduce growth of insects there and nearby insects and birds may replace that within a week. Spraying is costly as well as cause air and land pollution. Cutting of growing grass and shrubs surrounding airstrips may effectively discourage birds to land there. Shooting of birds by gun can solve the problem momentarily as soon artificial vacuum will be replaced by neighbourside birds. Heavy shooting of birds may disturb sentiments of people so also cause ecological imbalance problem in the area. Eco-biological management at aerodromes to control nuisance of birds at aerodromes is the best pragmatic lasting solution with Aerodrome Environment Management Committee having one ornithologist to study the local problems and suggest various measures, accordingly which may be including reduction of food availability as well as rest, roost and breeding facilities near the aerodrome to reduce the menace.

REFERENCES

Vohra Bikram, 1982. Basti. *Illustrated Weekly of India*, 11-17 April, 1982.

INDIAN BIRDS PROBLEMATIC IN AVIATION AND THEIR MANAGEMENT

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ABSTRACT

Flight, intelligence, adaptability, sight are some of the attributes that add to the diversity in life of birds and in consequence, there is complexity in their over all behavioural pattern. These when coupled with activities like 'foraging pattern' *vis-a-vis* economic relationships (to our interests) affect an unparallel multiplicity in their economic status. Consequently the bird may assume varied economic status, which if, is negative, leads to categorise the species as 'problematic' or 'nuisance' bird. With variations in several biotic or abiotic relationships, the status of the species varies from situation to situation. Thus it is not feasible to provide abridged definition for a problem bird. Further both bird and the aircraft have 'flight' that is largely based on principles of buoyancy. Purely from technical point of view, equally weighed for both, bird and the aircraft, it is not ethical and correct to designate bird as problematic to aviation. As is well known all these points relate to conservation and natural ecological balance etc. Therefore, the subject in totality deserves deeper appreciations in wider perspectives. Unfortunately, the subject has so far, not received the attention it deserves, especially, from Ornithologists. This equally pertains to need of modifications in conventional approach of studies on the subject. The subject in reality comprises of numerous components, both applied and of basic nature. These when coupled with aviation, necessitate studies on distantly related subjects. Therefore, the subject is considerably different than the conventional ornithology and imperatively necessitates background

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of applied Ornithology. With these points in view it has been attempted to review the available information substantiated with certain relevant examples from India and abroad. Various methodologies on bird management relevant to Indian species and in Indian conditions have been discussed. For example, in India so far, management of problem birds in aviation has been with in the exclusive perview of Civil Aviation or the I. A. F. The pilots followed the laid down guidelines. This was invariably based on individual experiences, expertise and the borrowed technology from abroad. These points have been discussed in the article to indicate the management technology and scope of studies of relevance to our conditions. Bird movement has been discussed with relevance to available information to aviation viz., with flock density, especially in relation to habitat manipulation. The latter approach has been widely suggested even with planting of exotic and indigenous shrubs etc. Relevance of these have been discussed in various parameters. Certain aspects on chemo reception in relation to daily activity and foraging pattern have been discussed.

MANAGEMENT OF VULTURES AND PARIAH KITES IN PROBLEMATIC SITUATIONS AROUND DELHI

R. A. AGARWAL* AND R. K. BHATNAGAR*

Introduction

Bird aircraft collision or BASH (Bird Aircraft Strike Hazard) is truly a subject of accident involving bird and the aircraft. Obviously it depends upon aircraft and the bird, both affecting zones of each other. Bird collision or suction into aircraft engine results into various degree of damages and may often necessitate replacement of affected parts or may even result into complete loss of the aircraft. The degree of damage depends upon degree of impact affected by the collision pressure which depends upon the speed of the aircraft and the bird, weight of the bird and its body mass (surface area it would cover and injury it would inflict with collision) etc. Therefore extent of damages would also depend upon the part of aircraft on which collision has taken place. In case of suction into engines or even in cockpit secondary injuries to aircraft parts may also be affected viz., broken parts causing further damages to other part with collision or obstructing smooth movements, injuries to occupants of the cockpit or even fire hazards in the aircraft. All these in turn may affect aircraft flying. In case of unmanageability of aircraft, the aircraft may even crash and if it is over inhabited areas, may even result into further severe losses including chances of the loss of human lives on ground. The later can not always be over-ruled, unless of course, the pilot has withstood the injuries and is able to steer out the craft to some other direction at the cost of his own safety. Obviously pattern of accidents cannot be predicted to be of any particular design

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excepting with certain known examples based on available statistics (as dealt with by Shri H. B. Singh).

Previous speakers have given many details on bird strike hazards,¹ birds species involved² and economic losses³ due to bird collisions with aircrafts. Most of the speakers have emphasised urgent necessities of management of bird strike hazards to aircrafts and which have been largely with approaches involving habitat manipulations *i. e.*, denial of availability of food. Few speakers have suggested other measures available from International Air Safety Manuals which largely pertained to control measures generally followed abroad. Obviously applicability in Indian conditions due to various factors, in particular faunal variations, variations in the behaviour of involved species and the socio-economic conditions, in regard to involved persons, limit their applicability and utilisations. Besides these limitations, lack of studies have also limited the utilisations of concepts of control measures. A survey and perusal of literature would affirm lacunae of studies in India in particular those having bearings to applied economic ornithology. Thus studies on various components of integrated problem bird managements are grossly wanting. Of various measures, scheduling of flights in relation to bird movements over and across airfields, management of offal and garbage dumps (attracting scavenging birds), besides employing basic scaring methods have currently been what may be termed as current status of Management of Problem Birds to Aviation in India. In order to avoid redundant coverage, it is not possible to discuss in detail these and some other measures currently in vogue in India *viz.*, efficacy of spraying diesel emulsions on grasses along airstrips to control insects and replacement or use of Sodium lights to reduce concentration of nocturnal insects etc. Other measures like scheduling air flights with regard to bird movement across runways, although provides useful safety measures to civilian aircrafts, poses limitations to defence aircrafts whose flight schedule, movements etc., cannot always be restricted but for the 'birds to pass'. These, therefore, necessarily need supplementing support of other components of integrated management of problem birds in aviation, in particular against vultures and pariah kites which have largely been causatives of BASH in India. Therefore studies on these species were warranted.

1-3. Details on bird hazards, bird strikes, bird species involved and economic losses due to bird collision with aircrafts have been deleted as other speakers have also covered these.—Editors.

With above background, studies were undertaken during 1981 and 1982 in Union territory of Delhi and vicinity areas falling within 120 km radius from Delhi.

Methodology

Methodology followed in these studies comprised intensive field surveys for study of habitats, surveys of population, congregating spots falling within airfunnel and areas outside airport (of relevance to aviation safety). Under these, studies were undertaken on general abundance, identifications of spots where the species congregate, identifications of causes of congregation, garbage/offal collection sites, and pertinent behavioral aspects. In addition to these aspects, studies on toxic baiting of vultures and pariah kites were also undertaken. For these, studies were undertaken (conforming to procedural steps of U. S. Standards for testing Avicides) on screening of insecticides for repellency and for lethally toxic dosages were also undertaken. These were undertaken purely as research component under controlled conditions.

Collection of live material was made from Timarpur and Gazipur areas by the 'Nylon String Noose Traps' which could be perfected, only after long tests of various traps and netting operations. Acclimatisations of live birds was done by maintaining them in cages followed with transfer to smaller experimental cages. Process of acclimatisation was spread to three days for each step till the average food intake rate and behavioral responses were stabilised in the birds maintained in groups and finally individual birds in individual cages. Birds maintained in cages were provided feed (dressed meat waste from meat processing factories) and water in separate pans. Consumption of feed was evaluated after 24 hours. Pans for evaluation of moisture loss were maintained in similar empty cages. Experimental cages were maintained in Timarpur where congregation of Vultures and pariah kites is invariably met with *i.e.*, were maintained in natural environment to nearest.

Promising bait formulations were laid and tested in controlled conditions in Timarpur Sanitary Land Filling sites. Procedure followed comprised pre-baiting with waste buffalo meat dressings. For this various

4. Part of studies were financed by Grant in Aid Scheme of A.R. D. B.

pre-baiting 'stands' and pans were tested. These followed tests of toxic bait formulations laid on ground over hesian cloth or plastic sheets. Finally dead birds were collected and mortality count was made.

Due to extreme paucity of time it was not possible to undertake detailed studies on other connected aspects. Details on items studied are being dealt with under corresponding headings.

RESULTS

General abundance of Vultures and Pariah Kites

Within Union Territory of Delhi, the general abundance of these two types of birds (the Vultures and Pariah Kites) is met within number of spots, namely, the spots wherever food is available or is expected to be available (Plate-8). These may also be for roost, shelter or for water or even for 'basking'. On later, precise explanations and details are not possible at the moment. Thus general abundance could be to obtain food or at food source; explorations for locating food; for taking food, water or at the roosts may be temporary or permanent nature. Movements are most unpredictable, generally commencing little after sunrise attaining increasing index from 8.30 hrs onwards in case of Bengal Vultures. However, flight of Scavenger Vultures and Pariah Kites generally commences earlier than those of the vultures. In case of Bengal Vultures, flight commences, if few individuals have taken to flight viz., by scaring. In case of Pariah Kites, flock of birds may simultaneously take to flight at lower levels approx. upto 100 to 200 feet. While Bengal Vultures may take exploratory rounds before attaining higher altitude. There appeared lesser association of kites with flocks of Vultures. White Scavenger vultures first soar with Pariah Kites and with thermals soar with Bengal Vultures. Exploratory movements or flight of vultures is reduced little before sunset when they move either to permanent roosts or to temporary roosts which may be anywhere disturbance is less viz., trees, monuments or even on ground. Large trees are preferred but not as a rule. Roost once occupied by Pariah Kites are generally not taken up by Bengal Vultures. However Pariah Kites and White Vultures may occupy same roost generally in groups viz., at high tension power towers and on electric lines. In city area exploratory movements of Pariah Kites are more at tree top levels and is lower than those of Vultures. Movements of Pariah Kites have been observed even in close proximity to

Palam in Cantt. area and in spots exactly leading to landing of crafts at Palam. Congregations of these three species are maximum at spots food is available and that movements of Bengal Vultures could perhaps be predicted with intensive studies, which are warranted with radar tracking and similar devices.

Observations on roosts revealed that often roosts (Avenue trees) of Whitebacked Vultures and Pariah Kites are in close proximity of residential premises. In such situations these species also attain status of urban nuisance birds. Therefore such roosting sites deserve management by mechanical approaches like pruning of tree tops and continuous scaring (keeping in mind air safety hazards) from permanent roosts which are expected to offer solutions. Urban Environmental and Land Scape Planners must keep in mind these aspects while plantations of Avenue Trees etc., are undertaken. Management of roosting birds with use of sticky roost repellents or contact insecticides are not advisable. Similarly toxic baiting of individuals from permanent roosts may not be effective. However, for management, spots where congregations are met with deserve identifications.

Identifications of congregation spots

Further observations on general abundance of Vultures and Pariah Kites revealed that 13 locations are somewhat of permanent nature where concentrations of Bengal Vultures, White Scavenger Vultures and of Pariah Kites is invariably met with Plate-9 and 10(1-3) show habitats of these species and are as follows:

1. Timarpur Sanitary Land Fields
2. Jamuna Bank opposite Timarpur Sanitary Fields
3. Bone Drying Dump opposite Timarpur Sanitary Land Filling Site (now removed)
4. Ring Road Sanitary Land Filling Sites (MCD and NDMC)
5. Old Fort Zoological Gardens
6. Idgah Slaughter House Area
7. Jama Masjid Area
8. Kasabpur
9. Shankar Road (irregularly)
10. Palam Village (generally Pariah Kites)
11. Pritampura.



- Plate-9/1 :** Animal carcass skinning operations at Gazipur during Rinderpest Epidemic in 1981. Background, showing congregations of whitebacked, Vultures.
- Plate-9/2 :** Garbage dumping operations at Timarpur Sanitary Land Filling site-Centre offal heap.
- Plate-9/3 :** Eastern side of Timarpur Sanitary Land Filling Site with Out House of T.B. Hospital-a permanent roosting site of Vultures and Kites. In foreground, levelled garbage heap with wide spread Little Egrets.
- Plate-9/4 :** Timarpur Sanitary Land Filling Site with 'packs' of vultures (in centre) and avenue trees in background which are permanent roosts.
- Plate-9/5 :** Timarpur Sanitary Land Filling Site with Pariah Kites on ground in centre. Background shows residential complexes in close proximity of permanent roosts or trees.
- Plate-9/6 :** Meat Waste Heaps at Timarpur Sanitary Land Filling Site.

Photographs by R.K. Bhatnagar

Besides these many smaller spots in various locations were noted where vultures and Pariah Kites were observed viz., over Boat House Club grounds, Munirka, Vasant Vihar and Hauz Ki Rani. On many avenue trees coating of droppings indicated that these are occupied by these birds especially Bengal Vultures. Causes of movements of Vultures and Kites on aircraft approach route (to Palam) over Old Jamuna Bridge are difficult to interpret. It could be due to thermals/fast winds, illegal slaughtering and disposal in open of offal etc., between Yamuna Vihar to Seelampur) or flight movements (especially of White Scavenger Vultures and of Pariah Kites) emanating from Ring Road Sanitary Land Filling Sites. In view of aviation safety from BASH, monitoring and studies on this aspect are warranted.

Some congregating spots are often within very close proximity to human settlements and in thickly populated areas. However, congregations are maximum at Garbage dumps where too concentrations vary. Therefore, observations on such spots to identify the cause, modalities adopted for disposal deserve study with a view to find out any link of relevance to the population reductional programme by some sort of cultural techniques and for selection of experimental site, especially where toxic baiting programmes can be taken up keeping in view all safety parameters.

Identification of causes of congregations

Observations on the aspect revealed that congregations are primarily for obtaining food. Besides food, in other areas, these are primarily for roosts or for drinking sites or for bathing or even for 'basking' (by Bengal Vultures). Related observations on these points have already been dealt with under previous columns. These, therefore, indicated need of appraisal of garbage disposal system and at slaughter house, as to why, inspite of very efficient systems adopted that are better than many other parts of the country, the concentration of these birds is so high in Union Territory of Delhi. These are being discussed, primarily in view of the relevance to the envisaged investigations on Vultures and Pariah Kites and not with a view to discuss the efficiency of disposal system etc.

Garbage collection and disposal etc.

Information furnished are based on visual observations and inter-

views with MCD officials who wish to remain anonymous. Objectives of these observations undertaken are :

(i) Identifications of the links of relevance to the envisaged investigations namely the factors affecting congregations of these birds at the garbage dumps, (ii) Explore feasibility and find out if any observation could be utilised in mechanical habitat manipulation for reducing population by reducing the congregations either without toxic baiting or by utilising toxic baiting techniques - the main objective of the proposed project.

Observations have revealed that disposal of refuse at illegal sites are not known and deserve first attention namely in context to precise details on composition as well as disposal of kitchen refuse, garbage, illegal dressings of poultry, fish, piggery and even slaughtering. Therefore, management practices can not be effectively implemented. Besides these, the utilisations or disposal of wastes from meat processing plants/poultry, blood from slaughtering and bones of the slaughtered animals and bone drying at dumps in Union Territory of Delhi deserve utmost attention (Plate 8-1). These besides affecting concentration of the involved bird species also involve revenue returns* to the Government, if are, utilised besides offering possible sources of additional employment generation in various ways. Dried animal bones are perhaps sold at the rate of approx. Rs. 500 to 800 per ton and are variously utilised for a number of products. These are collected from almost all villages and dumped at a collecting point from where these are distributed or sold out to bone mills. In Delhi, daily turn out of these is in fair enormous quantity.

Large hotels, especially those utilising the dumping facilities of the NDMC grounds in Ring Road be asked to develop modalities for separating refuse items (viz., edible items for Vultures and Kites) themselves. This would not only afford better dumping facilities but would also reduce congregations of the involved bird species straight in the area of air funnel.

*In a small township, Hapur, Uttar Pradesh, Mr. Kuraishi stated that he provided 'dust bins' to a number of Houses for collection of bones from kitchen refuse and table refuse. Economic return from these enabled him to run a children school there.

Garbage disposal at MCD Grounds

Broadly, garbage dumped around Delhi dumping grounds, comprises city garbage, slaughter house waste, kitchen refuse (city refuse) and refuse from hotels (plate 8/2-6). Rough estimates of the involved economics in relation to involved works are as follows :

Total tonnage of garbage is approximately 6,30 000 tons annually, average daily garbage collection is estimated to be around 1500 to 2000 tons per day ; estimated dumping at unauthorised sites are not known. MCD has to maintain continuous vigil*. Wastes of slaughtered sheep and goats amounts to estimated 3000 per 6 days of the week ; estimated total slaughtering of buffalo per 6 days of week ranges 1000 to 1500. Consequently, estimated wastes from these and processing plants which are precisely not known. Similarly, precise details on wastes from slaughter house wastes production is not known. The available estimates (Table 1) necessitate and deserve attention for various reasons, namely

Table 1 : Estimated Slaughtering of Animals in Delhi

Location/Animal Slaughtered	Year			
	1977	1978	1979	1980
Delhi : Sheep and Goats	11,81,880	12,95,430	13,75,134	1231976
Estimated wastes disposed in quintals at ave. 5 kg/indiv. (Figures in quintals)	59,094.0	64,771.5	78,756.0	61598.8
Delhi : Buffalo	2000230.0	198837.0	267860.0	353860
Estimated wastes disposed (crop and intestines)	(Details wanting		(approx. ranges 350 tons/week)	
Delhi : Dressings from factories	Details wanting		(approx. ranges to 40 tons/week)	
Cannt. and other areas	Details wanting			

*There is need of providing extra monitoring facilities and legal administrative authorities to Municipal Corporation authorities to regulate and check illegal slaughtering and disposal of wastes in unauthorised sites. There is also need of provision of administrative machinery to implement these measures and develop public awareness.

the amounts of stomach, intestines and lungs discarded from the slaughtered animals. Proper management of these aspects would obviously reduce bird congregation besides affording utilisations. These, therefore, deserve attention of the relevant authorities, in particular the management of open sale of table products (dressed poultry birds) and illegal slaughtering reportedly done in Kasabpur, Palam Village and even reported to be at some sites in Shankar Road or Link Road in vicinity of Rabindra Rangshala (these have now been stopped).

Garbage disposal comprises collection from various points through fleet of trucks bringing these to marked sites and dumping at marked spots. This is levelled with bulldozers. Estimated available number of bulldozers in relation to amount to be levelled is low. The levelled spots are to be allowed to attain some compactness with drying or are directly levelled with building rubble. To avoid fowl smell, gammexene is dusted. With putrefaction often the site/spots attain "boggy" nature and alternate site is taken up within allocated ground. The number of stray dogs and pigs often disturb disposal process. These need management by shooting (by Municipal Vermin Elimination Squad) or otherwise, especially pigs which expose the levelled spots from where vultures etc., again start feeding and movement of dumping vehicles is not possible. Stray dogs disturb vultures and which take to flight. This process at the time of Flypast may pose a serious threat as soaring gradually attracts other individuals also. Fresh heaps of slaughter house waste is dusted with BHC. On such heaps birds do not feed till the surface is whitish *i.e.*, the BHC is not assimilated. Immediately after this birds start feeding. Therefore, studies on repellents are necessary and have been undertaken. Investigation on utilisation of these waste products are also desirable by suitable agency. At these sites, fly control is being very effectively done by Baygon Fly tents. However, in spite of best efforts by Municipal authorities the bird concentration in varying density have been noted at all the sites.

Observations pertinent to control aspects

It related to garbage dumping sites and related sites and are as follows :

Khadi Gram Udyog carcass Utilisation Centre, Pitampura, located middle of approximately a 50 acre plot which was an old dumping site,

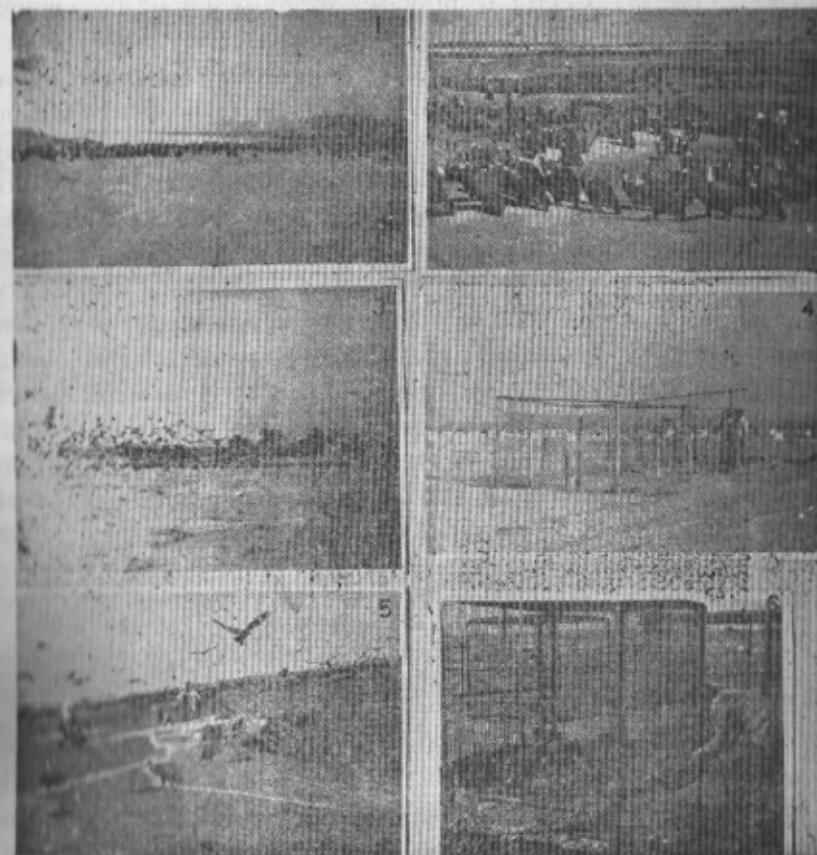


Plate-10/1 : Yamuna Bank at Timarpur with white-backed vultures (in centre) of bank edge.

Plate-10/2 : Congregations of Whitebacked Vulture on ground at Gazipur.

Plate-10/3 : Congregations of Whitebacked Vultures disturbed by stray dogs. Such disturbances induce flight in others and may pose hazards to aviation safety.

Plate-10/4 : Large automatic cage trap installed at Timarpur for tests.

Plate-10/5 : Field trial of nylon netting for on trapping 'packs' of Whitebacked Vultures on ground at Timarpur.

Plate-10/6 : Experimental Cages with Whitebacked Vultures.

Photographs by R.K. Bhatnagar

the site still has some exposed heaps on which 'pickers', hand picking recyclable products plastics etc, are seen. These reexpose the covered heaps. Centre is primarily for utilisation of dead animal carcass skinning and preparation of bone meal etc., Average receipt is about about 4-5 animals per day. The rotting carcass is often thrown out in open yard for Vultures to clean bones of the flesh. Such skeletons are maintained in heaps of dried bone. These are later auctioned. This point continuously maintains a large population of Bengal Vultures in varying density. The varying population density at the site clearly indicated immigration of population from neighbouring areas (plate 9/3-4). Therefore, such neighbouring sites in Haryana also deserve appraisal for management and population reduction of Vultures and Pariah Kites by integrated management approaches in Union Territory of Delhi. In any case the site at Pitampura deserve removal to other site on an urgent basis without delay. Such points indicate that similar plants in Haryana and Uttar Pradesh (at Loni, Hapur, Mansuri) which are close in context to flying time and 'reconnaissance' or 'circuit' etc., at radial distance deserve monitoring or even removal to some other direction. Location of future dumping sites and carcass skinning plants may keep in view these points especially movement of vultures and kites.

Timarpur Dumping Ground

The ground is spread over 800 acres of land but dumping is done in 50 acres of plot (plate 8/2). Besides city and kitchen refuse the slaughter house offal, the meat waste from meat processing plants (reported to be seven in Delhi) are also dumped here especially during the rainy season. However, precise time schedule for dumping of meat waste deserve attention for this attracts maximum amount of Vultures and Pariah Kites (Tables 2-4). Details have been dealt with under corresponding column in succeeding pages. Composition of dumping material was estimated and ranged 35 per cent of city refuse from urban Delhi. This is approximately 600 tons per day of which 8 trucks load is slaughter house waste that is dumped six days every week, besides average 5 to 10 tons of meat waste from meat processing plants.

Attraction of birds is maximum at slaughter house waste. For scaring to facilitate dumping or disposal, fire crackers are used at rate approximately 200 crackers per day, but usually it has been observed to

be lesser than the estimated quantity. Crackers, however, have limited efficacy and should not be used at the time of flight schedule or when the concentration is at maximum in ground for scaring promotes irregular flight leading to soaring which eventually attracts others from the neighbouring sites. At the site, the ground strata is rocky and water scarcity needs management for dusting of BHC etc. Bone drying or collection dump earlier maintained opposite Timarpur dumping ground continuously maintained the attraction of large number of Bengal Vultures. It appears that some regulation is needed to reduce such problem spots. It is heartening that now this dump has been removed by the municipal authorities. Jamuna bank (Plate-9/3) opposite the dump also maintains a large population of Bengal Vultures, the White Scavenger Vultures and the Pariah Kites. These settle on sandy island to bask, even bathe in river and also to drink water. Local inhabitants reported that in summers when area is under cultivation, settling of these birds is less. Investigations on shifting of these populations would be interesting for management etc.

Avenue trees opposite the site are amidst heavily populated buildings and are abundantly used by these birds as roost and are serious nuisance in these localities including in a T.B. Hospital (Plate-8/3 and 8/5). Therefore, deserve population reduction as well as management in the sites. Now some habitat manipulation by chopping of tree tops have been taken up.

With above informations in view of various experimental facilities etc., especially availability of experimental material in natural environment (50 acres plot of enclosed area) the site was chosen for experimentations.

Ring Road Sanitary Land Filling Sites :

These sites are under the administrative control of MCD and NDMC. Total area roughly is 80 acres and filling is done in low lying spots. The dumped refuse also comprised considerable amount of meat that is enough for attraction of vultures, especially the White Scavenger and the Pariah Kites. Their concentration is very high. These abundantly used the high tension power cable towers for roosting as a permanent roosts. These, therefore, deserve fixture of mechanical device to (a simple serrated metallic strip over these) reduce bird roosting and consequently built up of their congregations. It has

also been observed that as and when dumping operations (generally w.e.f. mid December) are stopped, there is a rapid shift in population of these species.

The area falls over aircraft approach. Therefore, Municipal and I.A.F. authorities have adopted a regular management practice to flight safety of shifting garbage dumping from this ground to Timarpur dumping site. It is felt that since birds concentration and their flying on the site with shifting movements to other areas poses threat to both civil as well as to I.A.F. Fly Past and also to aviation from Safdarjung Airport, the site may be removed permanently. However, prior to its shifting studies are warranted on bird movement. Details on estimated population counts are given in tables 2-4 and amply indicate increased population of these birds in Delhi.

Table 2 : Estimated population counts of Vultures and Pariah Kites in Delhi area during October-December 1981.

Area	Bengal Vulture	White Vulture	Pariah Kite
Timarpur	300	500	500
Yamuna Bank	3000	200	100
Pitampura	80	20	50
Ring Road	100	200	300
City Environ.	500	1000	100
Build up with influx/immigration	11,000	1000	3000

Table 3 : Approximate habitat wise visual counts of white backed (1), white scavenger (2) vultures and Pariah Kites (3).

Habitat	Period								
	Oct. 81			Nov. 81			Dec. 81		
	1	2	3	1	2	3	1	2	3
Timarpur									
On ground	50	100	50	200	300	200	300	200	200
On Poles	100	90	0	350	300	0	500	250	5
On Garbage	100	100	100	300	300	80	350	370	200
On trees	100	20	200	150	80	20	200	?	200
On Monds	?	5	120	10	15	300	10	7	100

Table 4 : Maximum Population Counts of Vultures and Pariah Kites in Delhi.

Location	Bengal Vulture	White Vulture	Pariah Kites
Timarpur Dump	700	500	900
Bone Dump	640	123	100
Yamuna Bank	5000	600	260
Trees	2000	200	2000
Elec. Power lines and Towers	19	500	3000
Over old bridge	250	158	479
Maujpur	370	269	590
Redfort Vicinity	?	100	470
Pitampura	300	80	200
Slaughter House and Kasabpura	300	200	500
Zoo	80	60	200
Ring Road Dump	140	450	560
Chirag Delhi and Kutub	80	50	130
Munirka	S 190	123	245
Cannt.	S 50	S 90	120
Subroto Park	S 100	S 90	S 230
Todapur	569	20	S 70
Shankar Road	S 90	S 90	S 240
Rajpath			
Ghaziपुर	500	20	10

S=Doubtful

Titik Nagar Dumping site :

At the site city refuse is collected and is quickly covered up as building rubble is generally abundantly available. However, often this also attracts problem birds.

Kailash Nagar site :

Kailash Nagar site receives 20-25 truck loads of refuse. At the time of observation no bird other than some Egrets were seen at the dump.

Cantt Butchery :

This premises is although completely fly proof, yet attracts a good number of Pariah Kites that usually soar at tree top level or little over. Precise information on their movement and congregations are wanting but could pose problem to aviation safety. Connected Butchery is said to handle slaughtering of a large number of sheep and goats, rejected meat is said to be burned in incenerator (precise details not known). In slaughtering, some blood drains out in open through a drain, along which some meat pieces also pass out and are also said to be pulled out by stray dogs. This eventually attracts Pariah Kites. Offal disposal is said to be managed by contractors. Precise details on this are not known and deserve attention, if problem is desired to be managed. This observation was pointed out in one of the meetings of I.A.F. Committee on Management of Bird Hazard. It is heartening that since then needful actions are being taken up by concerned authorities. Offal dumping is said to be on an average range, one truck load every day, for 6 days a week. Some persons are also of the opinion that offal is dumped at Subroto Park dumping site. No bird or fowl smell was, however, noted at this site. In any case this needs management in view of anticipated bird problem so close to Palam.

Subroto Park Dumping Site :

It is very close to Palam Airport and if any time problem birds are attracted it may create serious problems. Area is rocky where Cantt. garbage is said to be dumped at the rate of 8-10 truck loads per day and Cantt. Butchery offal at average rate of 1/4th truck load (more on 3 days when slaughtering is done there). Offal is sprayed with 5 per cent Malathion and covered with building material or lime at rate of 10 quintals per day. However, open exposed garbage was seen on days of observations but no problem birds other than one Hawk species was seen. This indicates that either the site attracts smaller birds or may be harbouring rodents. However, possible congregation of Pariah kites on kitchen refuse and slaughter house offal can not be overruled.

Palam Pottery Area :

No such dumping site was noted excepting existence of a small Poultry Farm extremely close to landing track of Palam Airport. Some feathers of dressed up chickens were also found and 6 soaring

Pariah Kites were noted which were scared from the site. It was reported that on main highway to Gurgaon often stray dogs are crushed under Vehicular traffic on the high way. Later on their carcass vultures settle and these need monitoring and management.

Delhi Zoological Park :

Discarded feed from pans are dumped near about Veterinary Hospital within the campus. Trees near the spot indicated roosting of vultures and this requires management. Therefore, it was brought to the notice of zoo authorities who immediately stopped the practice. It was also observed that many of the trees within zoo Campus are regularly used by Pariah Kites for roosting.

I.A.F. is said to be monitoring these and deserve impetus to the efforts, especially for other areas too in view of high economic returns of such efforts (safe guarding aviation hazards against birds), feasibilities of employing ex-service men for the job may be explored.

Besides the recommendations, outlined along with the corresponding points discussed in previous pages, these observations also indicated certain other points needing attention. These in brief are as follows :

1. Meat processing plants all around Union Territory be asked to define modalities adopted for dumping or disposal of their factory wastes. If dumped or removed by their contractors, they be asked to define the site and periodic dumping is done or it is sold for further utilisation and site utilised for the purpose.

2. Bone drying dumps all around Union Territory of Delhi within a radius of atleast 80 km be put into continuous surveillance as movement of problem birds may also emanate from these spots.

3. Cantt. Butchery and Slaughter House in Delhi should improve their systems. Jama Mazjid and Slaughter House area to be put into continuous surveillance for monitoring bird congregations and movement. Existing slaughter House and shops indulging in dressings of table products of fish, poultry and mutton etc., in open areas in Urban Delhi be shifted elsewhere and no discarding of waste product be allowed. Municipal authorities are regulating these aspects now.

4. Pitampura dump (Khadi Gram Udyog Unit) and dump opposite Timarpur be removed farther away.

5. Roosting sites within urban Delhi/New Delhi be mapped. Existing sites be cleaned for it may be attracting further birds as vultures and Pariah Kites do not frequently change such sites but do interchange. Investigations on manipulations of roosting sites without much altering architectural structures and pruning of tree tops deserve attention.

6. MCD be provided impetus to investigate utilisation of garbage for faster disposal viz., production of gas.

Foregone observations have indicated that habitat manipulation especially through dumping processes is not likely to provide immediate solutions towards reducing the population built up in Union Territory of Delhi as the process would be time consuming and as many agencies will have to be involved to implement these. However, these being important components of integrated management warrant studies.

Trapping : Foregone observations revealed that trapping of the live material has got to be undertaken from the habitats commonly affected by these species. Perusal of relevant literature revealed total absence of information on the subject. The generally followed method of using mist nets were found to have limited usages due to several reasons especially non availability of nets in India and poor durability for heavier birds. The indigenous products (nets) tested were found to be reasonably effective. Unfortunately, these could not be obtained during the period in spite of best efforts.

Other objectives of the investigations were also that if any method is useful it may provide alternate approach for population reduction without using toxic compounds. Besides these, of course the aim was to obtain large series of live material for various experimentations under controlled conditions.

The Mitchells Trap (Mitchell, 1963) was not tested as observations indicated that these birds have different behavioral pattern and lights will scare them ; area affected will have to be kept dark and covered with nets over extensive area. This was not possible.

'Automatic cage trap' was fabricated, installed and was put into operation for about 10 days at Timarpur (Plate-9/4). Birds did not affect it due to some sort of 'behaviorial aversive response to the new object'. However, it is believed that if the trap is left continuously

in the habitat and the size is still larger, it may show promise and therefore needs investigations. Studies on such alternate approaches were obviously desirable.

Netting : was variously tested. First it was attempted on congregations of roosting and basking birds in sandy islands opposite Timarpur Sanitary Land Field and was attempted to exploit behavioural studies for trapping the white backed Vultures, especially from roosting or basking 'packs' close to water edges-bank of Yamuna river. The method could not be tested on White Scavenger Vultures which are met within similar environments as wide spread individuals on same habitats and patches are affected by Pariah Kites. Since Bengal Vultures are most serious threats to birds strike to aircrafts, concentrated efforts were first directed to this species. Further if toxic baiting investigations are found successful on larger, more heavier carnivorous birds, the approach is likely to work for other smaller species with slight modifications. With this background, netting was attempted.

Netting of Bengal Vultures comprised stretching of large nylon gill net of 2 to 4 cm mesh size along the sandy slope. The Vultures from the 'basking packs' were driven towards the net and which was hurriedly moved against their movement direction. The approach did not provide any success in spite of repeated attempts. Main limiting points were that movement of men handling the net and their raising could not be faster on sand. For this net size has to be still larger to cover more than 200 mt length and that contrary to popular belief, Bengal Vultures are able to take to flight with a stride of bare 1.5 mt or even lesser. Even at this low level they are able to manoeuvre over the net. This is facilitated by the slope over the river water surface where simultaneous movements for trapping operations is not feasible. Similar approach was attempted on harder ground in Gazipur. Unfortunately, the netting did not prove strong enough to support 40 odd Bengal Vultures (Plate-9/5). Perhaps available netting was weak due to weathering etc. This followed similar experimentations with Military Camouflage nets. These were attempted at 4.00 hrs, so that birds can not see. Unfortunately, due to cumbersome nature the net provided limited efficacy.

Cast nets thrown over feeding packs at carcass and offal heaps, provided no result due to uneven surfaces over which the feeding is

generally resorted to by these species. It appears that the tinkling noise produced by 'sinkers' of the cast net scares the bird. After repeated attempts in Timarpur, Gazipur and Loni the method was discarded. It was also attempted that instead of moving on foot, the net thrower moves on a carcass carrying cart which does not scare the birds. This too proved of limited usage mainly due to agility of birds etc.

Nylon String Noose Traps : of various dimensions, made out of strings of different strengths were tried. The operational process comprised fixing, setting of nooses and stretching the string supporting the nooses on poles in the area in direction the resting population of involved species is expected to move. These were also put in direction the birds could be conveniently moved or driven by workers towards the traps. All these were in relation to prior behavioural studies of these birds. For example, abundance and feasibilities of trapping Bengal Vultures is maximum from roosting or basking populations on plain grounds. Trapping of white Scavenger Vultures and Pariah Kites was observed to be maximum at the garbage dumps. For trapping of later two species, behavioural observations indicated that trapping is feasible with similar noose traps made out of Fishing Twine of no. 8. Noose traps proved most effective and all the material used in the investigations was obtained by this method. Efficacy of these has been described in a succeeding article.

Release of trapped birds required very careful handling. For this leather gloves of elbow length were used. Birds endangled in the traps were first gently pressed with a wooden stick followed with release of nooses from the body. The noose could be anywhere and required immediate attention for, if the noose were on neck struggling bird is likely to strangulate itself.

Handling and transport of the live material

Trapped birds were put into gunny bags and were transported to the experimental site for transfer into stocking cage. However, handling of live material required to be done carefully. The process comprised of holding Bengal Vulture individual little below head keeping the body gently pressed lest the bird with fluttering of wing creates problem. This followed instant holding or grasping of legs to keep the powerful claws in control. Once these were done the bird was found to be quite docile rather in

control for putting into bags for handling. In case of White Scavenger Vultures, individuals were held by the primaries keeping the beak to otherside. Observations revealed that contrary to belief, White Scavenger Vulture is quite docile bird. Similar process was followed for handling live Pariah Kites which too appeared quite docile when handled and is contrary to popular belief. However, in handling Pariah Kites, care is needed lest it bites.

Stocking and acclimatisation

Field trapped or collected healthy individuals were put into large cages with other individuals of the same species to subject them to gradual acclimatisation to captivity conditions. After a day or so these were put into smaller cages. Food (meat waste) and water were separately provided in earthen bowls or in metallic bowls. After two days these individuals were separated and were put into individual cages for precise experimentations. However, the individuals were provided with known quantity of feed (meat waste) and water. When the individuals showed normal behaviour as evident from food intake and activity, these were taken as fully acclimatised and ready for experimentations (plate 10/6).

Experimentations with toxicants

Procedure followed comprised the widely followed methodology (US Standards for Tests of Avicides). For these, three species (Bengal Vulture, White Scavenger Vultures and Pariah Kites) were separately maintained in cages, these were weighed and sexed, acclimatised individuals were put into cages to make 3 replications and one as control (untreated). Known quantity of feed was given in bowls with known quantity of water in separate bowl. In an empty cage the feed and water was kept in similar type of bowls to estimate moisture loss with evaporation. Birds were starved for 24 hours for tests on toxicants (pesticides) commonly available in India. Screening of these were undertaken by mixing the chemical with the feed and provided to individual birds. For every tests on different doses separate individuals of bird were used. Bird individual once given a particular dose of a chemical was put under observation for a period of 7 days. Due to limited experimental cages available such individuals were numbered and transferred to stocking cages.

Preferred carrier used was meat waste-dressings (from buffalo meat) obtained from Meat Processing Factory in Delhi. This was done as field observations had revealed that maximum congregations of these species was on such feed when it is dumped at the dumping site (Plate-8/6). However, preference was investigated between various tissues (lung, trachea, intestine, crop and ligaments) that are generally dumped as wastes. These indicated that pieces of muscle tissues containing some fat pieces of 2 to 3 cm length and 3 to 6 cm width are most preferred. Such material was used as preferred carrier in all tests.

Effects of chemical Baits

Seven readily available chemicals were tested for efficacy as toxic baits on Vultures and Pariah Kites in dosages not expected to be harmful to spray operators. Large series of tests with number of varied dosages was not possible due to obvious reasons. Table 5 gives behavioural

Table 5 : Responses to chemical baits in Vultures and Pariah Kites

Chemical	Concentration/ dosage	Acceptability	Responses
Bromadiolone	0.25% on carcasses spray to make 4-6% conc.	Poor	Haemorrhage
Dichlorvos	39-50 ml/kg carrier	Slow	Acceptance poor delayed actions
Dimecron	50-60 ml/kg	Poor	Sniffed and rejec. ted, acts as feed- ing repellent
Endosulfan	100-150 ml/kg	Poor	-do-
Rogor	25 ml/kg	Poor	Not picked but repellency is short
Aldrin	20-56 ml/kg	Sniffed	Not taken spray- ed surface are not affected
Methyl Parathion	56-100 ml/lt.	Picked	Lethal Mortality in 1 to 3 hours

responses and indicated that sprays of Dimecron, Endosulfon and Aldrin respectively in concentrations of 50-60 ml/ltr, 100-150 ml/ltr and 20-56 ml/ltr (of formulated commercial products) act as feeding repellents. These when sprayed on feed (per 20 kg) are not taken by these birds. Baits prepared with 4-6 per cent Bromadiolone and 3-6 per cent Parathion are lethally toxic to these birds. Former chemical, however, Methyl causes internal haemorrhage due to which disposal of dead birds is somewhat difficult and also as requirement of chemical is more.

Toxic Baiting of Vultures and Pariah Kites

Studies on captive individuals indicated that food intake rate ranged between 0.50 to 1.5 kg in Bengal Vultures and 50 gm to 550 gm in white scavenger vultures and Pariah Kites. Studies also indicated that these prefer tissues with some fat, such whole pieces are ingested. Field observations showed that at meat waste or offal dump first Pariah Kites congregate followed by White Scavenger. Congregation of Bengal Vultures commences with warming up of sunlight. Other avian species do not affect such dumps. Further these species are habituated to congregate for feeding from ground excepting Pariah Kites which sometimes pick and take to flight or while on flight sweep to pick food pieces. It was therefore, imperative that baiting trials be initiated by laying feed material on ground in Timarpur Sanitary Land Filling site where birds are habituated to congregate for feeding. Further area is barbed fenced all around (to check intrusion by unwanted persons) and thus offers safety in baiting operations.

First procedural step in baiting comprised attracting birds on desired spots. For this dumping of meat waste (already ascertained and found most preferred food item) was arranged at known spot. Around 60 mt from the spot playing, dumping trucks and movement of personnels around the spot was checked. Intrusion of stray dogs and hogs was also checked as these also prefer the meat waste and their feeding activities scares vultures and kites. At these meat waste heaps, these birds were allowed to feed. For these tests untreated material was left in open for three days till drying up of upper portions and due to fowl smell it was found not advisable to leave in open, was covered it with rubble and eventually burried. During the process of developing congregation of these birds at these meat waste heaps dumping of slaughter house offal was regulated and all existing or incoming 'loads' were immediately

covered with and got dusted with BHC dust and rubble, so that birds do not move over to other spots. These steps comprised pre-baiting with untreated materials using most preferred carrier.

Table 6: Toxicants tested and estimated lethal doses for vultures and Pariah Kites

Toxicant*	Estimated LD 50 (oral) in mg/kg	Action (toxicity)
Bromadiolone	.005	Anticoagulant
Dichlorvos	80	Contact, stomach and fumigant
Phosphamidon	28	Systemic, Contact
Endosulfan	110	Contact, stomach poison
Dimethoate	250	Systemic and con- tact
Aldrin	67	Contact, stomach.
Methyl Parathion	9	Systemic, Frothy salivation
Malathion	2800	Non systemic
Landarin	208	Ineffective
Methiocarb	100	
Phorate	37	Systemic
Furadan	110	Contact and sto- mach

*Formulated products available were tested.

Above tests indicated that methyl parathion baits are suitable for toxic baiting of these birds and therefore, warranted controlled field testing of baiting technique.

Pre-baiting was stopped after 3 days, half portions of three successive meat waste heaps were sprayed with DDVP and Aldrin solutions to see the feeding repellency. It was observed that sprayed portions are not picked by birds or by stray dogs and hogs. Spraying with these chemicals was repeated and was observed that repellency lasts 2-4 days. Testing of repellency beyond 4-days was not possible as drying and

putrefaction of the exposed tissues takes place and such pieces are not preferred food items. Further rotting of exposed meat waste heap can not be allowed around environments.

After ascertaining repellents effect of DDVP and Aldrin, it was desirable to study feasibilities of attracting these birds to pre-laid 'bait stations' at baiting points which are not on ground.

Ten pre-baiting points comprising wooden planks (9"x6') fixed on wooden poles were fixed 30 mt apart in one of the plots at Timarpur Dumping site. Simultaneously ten baiting points each on 5'x5' plastic sheet and 20 earthen bowls were put on ground. Objective of these tests was to find out if these birds could be attracted to pre-baiting stations which would be above general ground level so that if there is any drainage of toxicant, it can be avoided. Tests with earthen bowls as baiting pans were undertaken so that if sufficient attraction can be brought about, eventual toxic baiting can be more effectively done with increased concentration and toxicant can even be given in water (liquid toxic baits). Pre-bait materials laid on plastic sheet on ground offered similar experimental manipulations and obtain safety factors. It was found that none of these pre-baits are effective enough to develop reasonable congregations of birds. Finally over brown plastic sheet, hesian cloth was spread over which meat waste was dumped. This was put in area where these birds frequent. Repeated observations for 3 days revealed that vultures and Pariah Kites do not show any aversive behaviour and congregate on these to feed.

This followed final trials on toxic baiting. Chopped pieces of meat waste was sprayed with Methyl Parathion solution to make it 4-6 per cent concentration by weight of meat. For spraying ordinary knap/sack sprayer or Hand sprayers were used taking all precautions (of pesticidal applications). These baits were laid on brown plastic sheet over which hesian cloth had been spread (Plate-10/1). Birds were allowed to feed.

As expected from previous behavioural observations Pariah kites first congregated followed by white scavenger vultures and finally Bengal vultures. Toxic symptoms in these species commenced with lethargic movements, belaboured breathing with gaping beaks, erratic flight for short distances, frothy salivation and finally death. It was, however, observed that depending upon intake of treated bait material, movement

and onset of toxic symptoms vary. Pariah kites and White Scavenger Vultures are able to take flight upto a distance of approximately 60-80 mt. radius and is generally to roosts. From such points dead birds are to be collected for eventual disposal by burying in minimum 3 mt. deep pits. In Bengal Vultures, perception of toxic symptoms appeared quicker. These lower neck and with swinging it are often start regurgitating the ingested material. This regurgitated material is often picked by crows in whom mortality is quite fast. Dead vultures were collected and were disposed off by burying (Plate-10/2-4).

Process of toxic baiting was repeated after a break of 2 days with pre-baiting with untreated material. Total mortality effected had to be restricted to permissible limits of 100 individuals of each species. Therefore toxic baiting at controlled field level were not repeated further in particular as the study objectives had been achieved. However, it is felt that initial pre-baiting be prolonged and after 2 days of toxic baiting, mid pre-baiting be scheduled to minimum 3-4 days. These studies have led to suggested undermentioned procedure for toxic baiting.

Procedure for pre-baiting* :

1. Locally areas/spots where target birds congregate be noted and time these birds settle on ground or concentrate be noted.
2. Untreated meat waste chopped in small pieces be dumped and birds be allowed to feed on the material.

Procedure for toxic baiting* :

Toxic baiting of any problem, nuisance or pest species is one of the components of integrated management and involves multifarious aspects. Therefore, success of toxic baiting considerably depends on simultaneous effective management of related factors. Further improper toxic baiting may affect population of non-target species also. It may also effect environmental pollution and besides many other aspects may even affect safety of personnel involved in toxic baiting. Therefore, operators should be fully aware of safety precautions and safety measures to be taken. They should also be aware of situation, area where toxic baiting is to be undertaken and other factors which are necessary to be regulated or checked. However, foremost is awareness to various connected aspects. For example, success of population reduction will be limited if

*Selection of baitings i.e be made taking into considerations all safety parameters.



Plate-11/1 Spraying of meat waste with toxicant for field trial on toxic baiting of Vultures and Pariah Kites.

Plate-11/2 Pariah Kite at onset of toxic symptoms after ingestion of toxic bait at Timarpur.

Plate-11/3 Dead Vultures and Pariah Kites after toxic baiting in Timarpur.

Plate-11/4 Dead Vultures after toxic baiting at Timarpur.

Photographs by R. K. Bhatnagar.

during pre-baiting, vultures and kites are allowed other food materials. Similarly disturbances to birds during pre or baiting periods, are to be completely checked. In addition to some of the above mentioned points, permission from State Wildlife Authorities is necessarily required for toxic baiting of these birds under Govt. of India Wildlife Amendment Act, May, 1982.

Covering most of the above points and studies described in foregoing columns under listed procedural steps are suggested for toxic baiting of vultures and Pariah kites if required to be done.

1. Permission from State Wildlife Authorities and competent Local Authorities for undertaking toxic baiting of vultures and Pariah Kites for reducing hazards to aviation safety.

2. *General Informations* : Through field surveys in area baiting is to be done, general informations on various pertinent points be collected viz. (1) Spots and sites these birds congregate and (2) Garbage/offal/meat waste dumps and areas where animal carcasses are skinned and spots where deskinning carcasses are left in open for vultures and kites to cleanse the flesh. Area where skeletons from slaughter house are left for drying of bones. (3) At such spots, time and periods when congregation of birds is maximum be noted. (4) Estimate of a visual count of birds and amount of feed available. (5) Selected 4-6 spots, 15 mt. apart and minimum 30 mt. away from skinning, bone dumping yard and from water points. These should be away (100 mt.) from human habitation and vehicular traffic. (6) Public awareness be developed on various pertinent points viz., such sites should be completely away from 'flight funnel' and circuit etc., skinning operations be done in covered enclosed sheds. In areas Khadi Gram Udyog Units of Carcass utilisations are existing, the animal carcasses be sold out to the units than letting vultures to devour flesh. In areas such centres are not existing, deskinning carcasses be dumped in pits and covered with rubble or clay. Besides some of the above points concerned public be made aware of toxic baiting, its hazards and safety precautions.

3. *Development of birds concentration* : (1) All existing food sources (animal carcasses offal and meat waste etc.) be removed or covered by rubble etc., or be sprayed with repellents. Materials sprayed with repellents can not be recycled for making poultry feed etc. It should be eventually buried in ground pits to avoid rotting and putrefaction. (2)

Spread [in spots as in 2 (5)] meat waste pieces of 3.6x4.8 cm on hesian cloth kept over brown plastic sheet (3x3 mt). At each spot 10-20 kg feed/spot (bait station) at interdistance of 50-100 birds. Allow birds to feed on these. Repeat the process for 4-5 days or till sufficient concentration. (3) All sorts of disturbance to birds is to be stopped viz., by stray dogs, hogs and by human elements.

4. *Baiting* : (1) Spray Methyl Parathion 70% EC at the rate of 80-150 ml/kg meat pieces (carcass). Mix it well with wooden stick. Contamination with other materials and safety precautions be kept in mind, that all other food availability is to be denied to birds and that birds are not disturbed. (2) Treated baits be put after pre-baiting has been done [cols. 2 (5) or 3 (2)], early morning around 6.30 hr. or so and birds allowed to feed. (3) Treated baits be left exposed till 17.00 hr. or till feeding of vultures and Pariah kites continues. After that left over treated baits be buried in 3 mt. deep pits. (4) Dead birds be collected from all around and buried in 3 mt. deep pits. While lifting dead birds, these be held by wings, collected in plastic bags and taken to dumping pits. (5) At onset of toxic symptoms some birds lower neck and with swinging movements regurgitate feed. Such feed be collected in flat pans (dust pans) and buried with treated baits. (6) Baiting may be repeated for 2-3 days or till concentration of birds continues on the material. When build up of concentration stops, baiting be stopped and pre-baiting with untreated material [as in col 2 (5)] be continued for 3-4 days or till sufficient concentration of birds develop. (7) Toxic baiting alternated with pre-baiting may be continued till desired objective is achieved. It should be however, kept in mind that toxic baiting is one of the components of integrated management. Therefore, various factors affecting congregations of these birds are to be managed and prolonged baiting in different spots of congregations may have to be undertaken.

Conclusions :

Bird Aircraft collision or BASH (Bird Aircraft Strike Hazard) is truly a subject of accident involving bird and the aircraft, both affecting zones of each other. Avoidance of the zone affected by birds in terms of altitude, direction and timings could be some of the measures for avoiding BASH. However, these cannot be worthwhile approaches for defence aircrafts in all situations excepting of course, for passenger air-

crafts which have more or less, scheduled course that to some extent can be timed in relation to bird movement. Available informations have also revealed that of various avian species involved in BASH, three scavenging species, Whitebacked Vulture, (*Gyps bengalensis*), white Scavenger Vulture (*Neophron percnopterus*) and Pariah Kites (*Milvus migrans*) are largely involved in BASH. Therefore, studies are warranted on these species.

Studies undertaken in Delhi and vicinity areas, lead us conclude that within Union territory of Delhi there are 11 spots where congregations of these species is regularly metwith. Besides these there are numerous other spots like those in 'flight funnel' and 'approach route' to Palam. These need monitoring for bird movement and causatives that attract these species like slaughtering and dumping of meat wastes etc., Amongst permanent congregation spots, the municipal sanitary land filling sites of Timarpur, Ring Road and Carcass utilisation Centre at Pitampura are few that need improvement in disposal system for quicker disposal in particular as production of meat waste and offal in Delhi is in enormous quantity. To these sites there appeared regular immigration from vicinity areas. Therefore in neighbouring areas also there is a need of management of problem birds and their preferred habitat. The roosting sites of these species are in close proximity to residential complexes in many areas. These also need management or even removal. The Kasabpura and Idgah Slaughter House Area needs shifting to some other site. Besides these management practices, there is a need of integrated management of these problem birds. Therefore, besides management of habitat, there is also a need for limited population reduction. Later aspect would be warranted if habitat manipulation is affected in various congregating areas i. e., to contain the surplus population from 'scattering' which would not have worthwhile role in such urban areas. However, for management of these species an integrated control approach is necessary.

REFERENCE

- Mitchell, R.T. 1963. The Flood Light Trap—a device for capturing large numbers of Black Birds & Starlings, at Roosts. Spl. Scienti. Report—Wildlife No. 77, Washington, D.C., 14 pp.

TRAPPING TECHNIQUES FOR VULTURES AND PARIAH KITES FOR APPLIED STUDIES

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Applied ornithology as a subject has already been established in relation to Agriculture, Horticulture and Industry. With the advent of jet-aviation, birds have become increasingly hazardous to aircrafts, during the flight. Indian Airlines have reported 149 bird strikes during 1980 and the repairs have exceeded rupees seventeen lakhs. This problem is bound to increase with further development of fast-flying aircrafts.

Direct strikes by large birds like Vultures and Kites, both flying at low and medium altitude, pose a serious hazard. Vultures being the most important scavenger bird, mass-killing is out of question. As yet no satisfactory measure to avoid such accidents is known.

To achieve the above ends, a detailed study on Ecology and Bionomics of vulture in field and laboratory is required. The present investigations were undertaken (in connection with various applied studies) to find out the best and suitable vulture catching technique.

The following methods were employed to capture vultures from the field by using various trapping devices.

Boom-type manual net : These nets are usually used by fixing the entire breadth of the net on ground and throwing the other end with the use of explosives. The loose end falls down with the help of weights tied on net, and it falls on the birds sitting on the ground. During the present investigations, explosives were not used, instead two workers pulled the two loose corners covering over the sitting vultures. Vultures being slow on the ground, it was convenient to use manual power instead of explosives.

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2. *Slip-knot rope technique*: A long rope with a loop having a slip-knot is carried slowly and carefully near the flock of vultures on the ground and is pulled as soon as it gets hold of the neck of the bird. It requires two operators to drag the rope and two to capture and release the bird from the rope-knot.

3. *Vertically-fixed slip-knot*: In this case a number of loops were stretched over the ground in a zig-zag manner. Then the birds are slowly driven to move towards the stretched catching device and then suddenly disturbed. This caused haphazard running and as such they got caught in the loops with slip-knot. This requires a larger group of workers to release the birds caught.

1. *Boom-type manual net*: The data collected by using this net is tabulated in Table 1. Nets of average width of 8.0 meters covering an area of approximately 200 square meters used ten times, with each type of mesh ranging from 1/2" to 2".

2. *Slip-knot rope technique*: A very slow process and involves patient working by the workers. This has yielded a maximum catch of 5 Vultures per day and involved extremely efficient workers.

3. *Vertically-field slip-knots*: Each operation covered approximately 1000 square meters with 1000 slip knots. Number of attempts were 30 with different cord strength (Table II). The Vultures can only be caught with loops made of cord number 15, 20 or 24. The best results were obtained in No. 24. Higher number of cord will make the net heavy and unmanageable.

The investigations carried out prove the efficiency of vertical fixed slip-knots over all others. The slip-knot rope technique is not suggested due to slow catch. Boom type manual nets is completely rejected. The only practical vulture catching device is vertically fixed slip-knot technique.

For catching Pariah kites and White scavenger vultures, slip knot rope technique is equally useful. Only thinner nylon thread is to be used. Mist nets are though useful but are expensive as net is an imported item. The automatic cage trap as shown by Bhatnagar and Raizada (1975) can also be useful after birds have acclimatised to new object reaction.

Table 1 : Trapping of Vultures with nylon nettings of thread No. 0 at Gazipur

Mesh diameter	Number of attempts 10 in each case										Total No. of Vultures caught	No. of Vultures escaped		%
	1	2	3	4	5	6	7	8	9	10		Number of vultures		
2"	8	10	11	0	7	9	7	4	8	0	44	44		100. %
1"	0	0	4	8	9	11	12	7	9	0	60	60		100. %
1/2"	10	8	1	6	9	0	6	5	8	4	57	50		87.7 %

Table 2 : Trapping of Vultures with nylon noose traps at Gazipur

Nylon cord No.	Number of attempts 10 in each case										Total No. of vultures caught	Vultures escaped		%
	1	2	3	4	5	6	7	8	9	10		Number of Vultures		
15	6	4	9	0	6	5	8	4	0	2	44	36		81.8
20	0	0	8	4	7	6	5	8	3	1	42	32		76.1
24	5	4	9		3	0	1	4	9	3	45	20		44.4

PART II

Management of Problem Birds
in
Agriculture

ENVIRONMENTAL ENDOCRINOLOGY OF REPRODUCTION OF INDIAN BIRDS*

J. P. THAPLIYAL

ABSTRACT

India is rich in avifauna, but food physiology, reproduction biology and behaviour of birds is poorly understood. Of 1240 species of birds found in this sub-continent, information on annual cycles of reproduction of 38 species, on body weight of 9 species and on the factors—environmental and hormonal—that regulate the breeding and body weight cycles of 4 species alone is available. Results indicate that by manipulating environmental factors, like quality and quantity of available food, humidity, thermo-period, photoperiod, etc. that act either directly or by way of thyroid and adrenal on the hypothalamo-hypophyseal complex, reproduction and body weight of birds can be regulated. However, more information collected at different points (latitudes) in the country on the food and feeding habits, influence of different environmental factors including chemicals used in agriculture and industry on the behaviour and breeding of birds is required before a sound scientific policy of bird management can be formulated. Meanwhile, however, steps can and should be taken to ensure that the activities of modern man are not inimical to our avifauna.

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*Full paper was not received and abstract was taken as read.

THE IMPORTANCE OF BASIC RESEARCH IN BIRD BIOLOGY AND MANAGEMENT

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Birds are involved in many complex interactions with Man, their impact on national economy vary from very harmful as in aviation to neutral and beneficial in other fields. Bird management in India should involve controlling the harmful species and encouraging the beneficial ones. For either task one should have a proper understanding of the ecological requirements and economic status of birds.

From the pioneering research work of Mason and Maxwell Lefroy (1912) and of Salim Ali and Co-workers and other recent bird students; we know that birds have a double role in agriculture. As the geographical and ecological conditions vary considerably from one region to another one has to study their status, feeding habits, breeding biology and population dynamics in different areas in relation to agriculture. Then only could one think of making generalisations about how to control birds (Ali, 1936). In my experience with Indian birds associated with agriculture I have found the following aspects worth studying from the point of controlling birds.

Plumage and moult of feathers.

Those engaged in enumerating birds in crop-fields and other area will have to judge the age of the bird based on appearance. Birds often vary much in colour from stage to stage and in the breeding and off seasons, e. g. case in the Baya (*Ploceus philippinus*) at Rajampet. Here birds of all age groups looked alike in winter. This could be true in other ploceiid birds too.

Food and Feeding behaviour.

The type of food consumed by the nestling bird is often different from that of the adults. Even the grain eating species feed their nest-

lings on soft invertebrate particularly larval arthropod food e.g. the case of the Baya in Rajampet. When cultivated grains are not available and sometime even along with paddy and millets a grainivorous species of bird consumes quite a lot of weed seeds. The schedule of feeding of the same species of bird is not the same in its breeding and off seasons. Nesting birds use most of their time to collect food for their young. Thus the feeding habits of grainivorous species of bird with all their (apparent) potential for causing undiluted harm to crops may be only neutral in economic effects. Only systematic study in different regional stations can reveal the true economic status of a species of bird.

Breeding biology

Breeding activities occupy a long period of time in the annual cycles of birds and place a great strain on their energy. The breeding season is a very sensitive period for birds as the adult birds are considerably weakened and young birds subject to high degrees of mortality at this time. As the adult birds feed much less and as the nestlings consume considerable amounts of arthropod pests of crops, the breeding period of grainivorous ploceids is favourable to agriculture and should be exploited. For example the breeding activities of the Baya weaver can be artificially prolonged by plucking out nearly complete nests.

Population Studies

The natural populations of birds are likely to be clumped in favourable area. Their crude density and ecological density may be very different e.g. the results of a weekly count of the Baya at Rajampet in 280 ha at Reddipalle. The damage that this population could do to the crop of paddy in the area was negligible. Conditions elsewhere could be different.

Local Movements

Even non-migratory species of birds move some distance to change their roosts and feeding grounds as the layout of crops is changed. It is essential to have precise information about local movements of birds in relation to agriculture.

In my opinion such broad based investigations of the fundamentals of the biology and ecology of birds should precede the measures for their management. Otherwise the steps taken will not be realistic.

Full paper was presented but manuscript was not received.

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PROBLEM BIRDS AND THEIR MANAGEMENT IN PUNJAB

H. S. TOOR*

Introduction

It is a matter of common knowledge that birds attack many crops at sowing time, at the seedling stage and from the time of seed-settling until harvest. They also cause much damage on the threshing floor but significant losses are caused at grain storages. Due to the shortage of proper godowns, huge stocks of grains are layed in the open stacks. One feels pity the way valuable cereals are being damaged by birds and weather conditions. At the storage houses pigeons, doves, parakeets and house sparrow cause considerable losses. There is substantial loss of the gunny bags too. Much damage due to birds to a large number of ripening fruits has also been recognized.

Birds are not a new problem. References to damage caused by them have been made periodically during the last five centuries. The havoc played by them has led to the enactment of laws for their control in Britain since fifteenth century.

In India very little attention has been paid to investigate the role of birds in agriculture. However, from Punjab region, preliminary information on food and feeding habits of the common birds has been provided by Husain & Bhalla (1937), Ali (1964) and Ali & Futehally (1967). At Punjab Agricultural University significant observations pertaining to feeding behaviour, extent of bird damage to different crops have been made by several workers (Ramzan & Toor, 1972, 1973; Toor & Ramzan, 1974a, 1974b, Chahal *et al.*, 1973; Simwat & Sidhu, 1973; Simwat, 1977; Toor & Sandhu, 1979, 1981; Sandhu & Toor, 1980; Dhindsa & Toor, 1980). The house crow (*Corvus splendens* Vieillot), the rose-ringed parakeet (*Psittacula krameri* Scopoli), blue-rock pigeon (*Columba livia* Gmelin) and common myna (*Acridotheres tristis* Linn.) are the most common birds of the Punjab and on the basis of the recent

studies they have been rated as harmful birds causing considerable damage to grains and fruits.

Before the control measures are applied against birds, there is a dire need to establish the economic status of the bird. It is not an easy job to state which bird species is harmful and which is useful to us. A species useful at one place may be neutral at the other or even harmful at some other place. The economic status of a bird species differs geographically due to the different environmental conditions and agricultural practices being adopted in different regions. Keeping this thing in view, we must take the complex ecosystem into consideration of which the birds are a component. In order to assess the exact economic status of birds in a particular area having particular climatic conditions, there is a dire need of precise and specific investigations.

Problem Birds and Damages affected

From Punjab region, studies have revealed that some birds, such as house crow, *Corvus splendens* Vieillot; house sparrow, *Passer domesticus* (Linnaeus); rose-ringed parakeet, *Psittacula krameri* (Scopoli); bank myna, *Acridotheres ginginianus* Latham; ring dove, *Streptopelia decaocto* (Frisvaldszky) and blue rock pigeon, *Columba livia* (Gmelin) are harmful to many grain crops, vegetables and fruits in the Punjab State (Table 1). It has been estimated that house sparrows damage wheat (16%), bajra (29%); house crows destroy wheat seedlings (17%), maize seedlings (20%); bank mynas spoil grapes (19%), parakeets destroy maize (12.4%), sunflower (22%), sarson (63%), guava (20.1%) and almonds (7.33%). Peach suffers upto 32.21% losses due to parakeets and crows. Weaverbirds and sparrows damage rice nurseries (41%). Pigeons, doves and sparrows cause a serious problem at grain stores and rice sheller yards. Owing to changes in the agro-ecosystem, i.e. the cropping pattern and the coming up of new orchards, it has become all the more important to analyse the seasonal feeding habits of these birds in different agro-ecological conditions.

In addition to the damage to agricultural crops and fruits, birds impose serious problems to the aircrafts during flight as well as at the airfields. Our studies (Toor & Sandhu, 1980) have revealed that the birds attracted to the airfield areas having diverse natural vegetation around it often collide with the aircraft and pose threat to it. Also birds are a source of urban nuisance and spread diseases infecting us,

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our crops and our livestock. All these activities of birds compel us to control them.

Control measures

The pre-requisites for the control of a bird species are the studies on its feeding, breeding and roosting ecology. Only with the help of such studies, a suitable control technique can be effectively applied against a bird pest. Different methods have been tried from time to time against different harmful birds but so far there is no single method available which can be effectively applied against any harmful species in any situation. However, very little is known about the control aspect of the Indian harmful birds. In Punjab, beginning has been made in this direction and the works of Bindra & Toor, 1972; Chahal *et al.*, 1973; Sidhu & Simwat, 1973; Simwat, 1975; Dhindsa & Toor, 1980 and Toor & Sandhu, 1981 deserve special mention.

All the methods used to tackle bird pests can be dealt with under three main headings viz., (I) mechanical control methods, (II) checking of bird population, (III) chemical control methods and (IV) biological control methods.

(I) Mechanical control methods

These include scaring the birds away, reducing their number, manipulation of their habitat, physical protection to crops and orchards with nets and using cultural practices.

Scaring: The following methods have been used for scaring the birds away:—

(a) **Scare Crows:** These have been used in crop fields since ages. The main drawback of scare crows is that birds cease to be scared after some time.

(b) **The use of sling shots:** Sling shots is made of two rope strings and a piece of cloth which is swung to throw a mud pebble at bird congregation. It has been used in India since at least 1300 A.D. It successfully scares birds away from crop fields and orchards.

(c) **Drumming:** It is also an ancient and the most popular method used in orchards.

(d) **Automatic bird scarers:** These scarers also known as bird scaring guns and automatic acetylene exploders, produce loud exploding

noise (due to sudden burning of acetylene gas) which scares the birds away. In the beginning this method was used at airfields. These scarers are very cheap and require low operational cost. However, like scare crows, birds soon get habituated to the noise. This can be effectively overcome by camouflaging, changing their location periodically and supplementing it with actual gunshots occasionally.

(e) **Bioacoustics:** Out of the various biological communication calls of birds, only the *Distress calls* and the *Alarm calls* or *Warning calls* have been exploited in bird control. Method basically comprises recording of calls followed with play back through a loudspeaker.

There are many problems in employing bioacoustics in bird control, namely some birds never produce distress or warning calls (Pigeons). Despite these problems, bioacoustics has proved fruitful in scaring the birds away. Preliminary studies have revealed that the distress calls in case of parakeets can be quite effective for scaring birds in guava orchards for the first few days only.

(II) Checking of bird population:

By reducing the population of harmful birds we can surely reduce the problems imposed by them. Various methods commonly used for population reduction are discussed below:—

(a) **Shooting:** The old practice of shooting, besides killing, also helps in scaring birds away.

(b) **Traps & Nets:** Various types of traps and nets, manually operated or automatic have been used. Amongst automatic traps, the potter trap and the modified Australian crow trap are worth mentioning. Decoy traps have also been used successfully in other countries to capture bullfinches and starlings. Like traps, there are many types of bird trapping nets ranging from the simple small-meshed ones to the fine Japanese mist-nets. The best use of traps and nets is that we can release the useful or neutral species of birds which are also liable to be trapped along with the target harmful bird species. After trapping, the harmful birds can be killed.

(c) **Nest destruction:** This is the best way of keeping the population of troublesome species in limits. The nests and their contents can be destroyed manually. This should be done at the time when the breeding season of the concerned species is well advanced so that the

birds are unable to rebuild the nests and re-lay eggs. In Africa, fire is used to destroy nests of a colonial weaverbird pest, *Quelea quelea*. Nests can also be fumigated with aluminium phosphide.

(d) *'Netting' crops and fruit trees:* The crops and fruit trees can be physically protected against birds by covering with cotton or plastic nets. The use of plastic nets has been strongly recommended for vineyards and blueberries. Following benefits of the plastic netting system have been reported effectiveness, noiselessness, no damage to fruits, resistance against water and most chemicals and that they can be reused. But keeping in view the expenditure involved, it becomes impracticable to cover large crop fields and orchards. However, the netting can be used to protect small seedling nurseries (like that of rice) and isolated fruit trees.

(e) *Cultural practices.* Following practices have been suggested to reduce bird damage to crops : (i) deep planting to reduce damage to sprouting seeds, (ii) delayed sowing and planting—allows migrants to pass, (iii) cultivating quick ripening varieties to reduce exposure, (iv) early harvesting and drying of seeds with drier—to reduce damage at threshing floors, and (v) cultivating bird resistant varieties. The cultivation of quick ripening and bird resistant varieties can surely be effective in reducing bird damage. Many crop varieties have been reported to be bird resistant e.g. Sonalika and *Sarbati sonara* of wheat, PHB-14 of bajra.

(iii) Chemical control methods :

These methods include repelling, capturing, sterilising and killing of birds by using various types of chemicals.

(a) *Repellants.* These may be used as seed dressings, spray reagents dusts or as bait material. Some of these are : TMTD (Tetra methyl thiuram disulphide), anthraquinone, 2% lindane, 5% malathion, 5% BHC, eldrin and naphthalene dust, methiocarb (3, 5-dimethyl-4-methylthio phenol methyl carbamate), DRC-3324 (a butyramide dust) and 4-aminopyridine. Although by these chemical repellents the crops and orchards can be protected from birds but these may contaminate and render them unfit for human consumption. Besides other limitations, chemicals should not be phytotoxic and residues should be within tolerable limits.

(b) *Stupefying baits.* These baits stupefy the birds which then can be caught and killed. Important chemicals used as stupefying baits are : Avitrol-100 (4-nitropyridine N-oxide) and Avitrol-200 (4-aminopyridine) in wheat, sorghum and corn chops. These have been reported effective against sparrows and blackbirds. Alpha chloralose (1–2%) has been used against pigeons, starlings, and sparrows. One advantage of these baits lies in their selective usability i.e., the non-target birds can be allowed to recover and fly free.

(c) *Poison baits.* Poison baits can be prepared by many pesticides. These are : methyl parathion, carbofuran, ethyl parathion, monocrotophos and endrin for baiting crows, pigeons, sparrows and bank mynas. The baits are prepared by soaking 'chapaty' pieces in pesticide and drying these in shade. Grains can also be used for this purpose. Before providing poison baits to the birds, it is essential to do pre-baiting. Poison baiting, if carelessly done, can lead to secondary hazards. So the baits should be kept out of the reach of children and domestic animals and the left-overs of the baits should be properly destroyed.

(d) *Chemosterillants.* These chemicals reduce the reproductive rates of birds by sterilising them. These are cheap and easy to use but the only drawback is that their effect is not immediate. Commonly used chemosterillants are : Tetramethylmalamine (against starlings), and Azascolesterol also known as Ornitol or 'Pigeon Pill' (against pigeons).

(e) *Poison sprays.* In Africa, toxic chemicals have been sprayed to control *Quelea* weaverbird. With these poison sprays, about 400 million birds were killed between 1956 and 1960. The chemicals used for spraying are : parathion, fenthion and phoxim (O—cyano-benzylidene-amino co-diethyl phosphorothionate). "Queletox" (a formulation of fenthion) has produced effective control of African bird pest *Quelea quelea* at an average cost of £23.60 per ha. These sprays, however, cannot be recommended in India considering the possibilities of secondary hazards.

(iv) *Biological control methods.* Like other animals, birds also have many natural enemies which can be employed against them as biological control agents. So far, no attention has been paid on biological control of birds. Falconry has been tried to scare away the birds at airfields but has to be stopped due to scanty supply of falcons

Table 1. The depredations of birds on different crops in Punjab

Crop affected	Birds species involved in causing damage	The stage of the crop damaged	Extent of damage
I—Cereals			
1. Wheat			
	Doves, pigeons, pheasants	Sowing time	Reported but extent not known
	House-crows	Seedling stage	16%
	Weaverbirds, sparrows and parakeets.	Ripening to harvesting	Damage depends upon the variety of wheat (3—27%)
	Sparrows, pigeons, doves	Threshing	Reported, but the extent not known
2. Rice			
	Weaverbirds, house-sparrows and the common myna	Nursery-raising	41% by weaverbirds and house-sparrows
	Weaverbirds and house-sparrows	Ripening and harvesting	Reported, but the extent not known
3. Maize			
	Pigeons, doves and house-crows	Sowing time	Reported, but the extent not known
	House-crows	Seedling stage	20%
	Parakeets	Ripening to harvesting	10%
4. Sorghum			
	Sparrows, weaverbirds, crows, starlings	Ripening to harvesting	Extent depends on the variety (12.82-85.50%)
5. Bajra			
	Pigeons, doves	Sowing time	Extent depends on the variety (10.0—100%).
II. Pulses			
	Sparrows, weaverbirds, crows, starlings.	Ripening to harvesting	Extent depends on the variety (10.0—100%).
III. Oilseeds			
1. Groundnut			
	Pigeons, parrots, sparrows	Sowing time	Reported, but the extent not known.
		Seeding, pod formation, harvesting, threshing, drying.	Reported, but the extent not known
2. Mustard and toria			
	Pigeon, house crows	Sowing time	Reported, but the extent not known
3. Sunflower			
	House crows	Cotyledons	Reported, but the extent not known
	House crows	Pods dug out and eaten	Reported, but the extent not known
IV. Vegetables			
1. Chillies			
	House crows, parrots, mynas	Ripening to harvesting	Reported, but the extent not known
	Parrots	Pods	88% in one case
	Parrots	Earheads	Very serious and in some cases even upto 98%
	Pea-fowls and parrots	Fruits	Reported, but the extent not known

2. Methi & Palak	Sparrows	Sowing, seedlings, mature leaves	Reported, but the extent not known
3. Peas	House-sparrows, crested larks, parrots	Sowing, seedlings, pods (fruits)	Damage to pods, very serious.
V. Fruits			
1. Mango	Parrots, owls	Immature & ripened fruits	Reported, but the extent not known
2. Guava & Peach	Bulbuls, koels, parrots	Immature & ripened fruits	
3. Grapes	Mynas, sparrows, Bulbul	Immature & ripened fruits	Very serious damage in May, June by bank myna
4. Ber	Parrots	Immature & ripened fruits	Reported, but the extent not known
5. Jamun	Parrots	Immature & ripened fruits	Reported, but the extent not known
6. Figs	Parrots, house crows, koels, starlings, green pigeon, bank myna	Immature & ripened fruits	Reported, but the extent not known

*Source—Toor and Sandhu (1981).

and due to their inability to fly in adverse weather conditions like rain and fog.

Suggestions for effective bird control

The following suggestions may be useful in effective bird control :

1. The first and the foremost point for consideration is to identify correctly the apparently troublesome species and study its feeding, breeding and roosting ecology. This will help to assign the exact economic status to the species concerned.
2. After confirmation of the bird as pest, a suitable control technique should be selected which should be simple to operate, not too costly, and effective under given conditions.
3. The objective should be to solve the problem rather than to destroy birds. If the problem can be solved by using scaring techniques then there is no need of killing the birds.
4. The killing should be done to reduce the population only to that level at which it no longer inflicts economic injury. Total eradication of a species is not recommended as it may lead to serious upset in the ecological balance. While killing the regulations and bird protection acts must be kept in view.
5. For the effective control of harmful birds an integrated approach i.e. mechanical, chemical and habitat manipulation be adopted on regional basis.

REFERENCES

- Alli, S. 1964. *The book of Indian birds*, Bombay Natural History Society, Bombay.
- Alli, S. and Futehally, L. 1967. *Common birds*. National book Trust, India New Delhi.
- Bindra, O.S. and Toor, H.S. 1972. *Harmful birds and their control*. Farm Bulletin, Punjab Agricultural University, Ludhiana.
- Chahal, H.S., Simwat, G.S. and Brar H.S. 1973. Bird pests of crops and their control. *Pesticides*, 50 (9) : 715-719.
- Hussain, M.A. and Bhalla, H.R. 1937. Some birds of Lyallpur and their food. *J. Bombay nat Hist. Soc.* 39 (4) : 831-842.

- Mason, C.W. and Lefroy, H.M. 1912. The food of birds in India. *Mem. Dept. Agri. India.*, 3 (1) : 372
- Ramzan, M. and Toor, H.S. 1972. Studies on damage to guava fruit due to rose-ringed parakeet, *Psittacula krameri* (Scopoli) in the Punjab. *J. Bombay nat. Hist Soc.* 70 (1) : 201-204.
- Sandhu, H.S. and Toor, H.S. 1981. *Harmful birds and their control*. Farm Bulletin, Punjab Agricultural University, Ludhiana. pp.
- Sidhu, A.S. and Simwat, G.S. 1973. Studies on the control of house crow (*Corvus splendens* Vieillot) through poison baiting. *J. Res. Punjab agric Univ. Ludhiana* 10 (2) : 216-219.
- Simwat, G.S. 1975. Control of rose-ringed parakeet in Punjab. *Indian J. agric. Sci.*, 45 (6) : 269-272.
- Simwat, G.S. and Sih, A.S. 1973. Note on the feeding habits of rose-ringed parakeet, *Psittacula krameri* (Scopoli). *Indian J. agric. Sci.*, 43 (6) : 607-609.
- Simwat, G.S. 1977. Studies on the feeding habits of house sparrow, *Passer domesticus* (L.) and its nestlings in Punjab. *J. Bombay nat. Hist Soc.*, 74 (1) : 175-179.
- Toor, H.S. and Ramzan, M. 1974a. Seasonal food and feeding habit of birds of Punjab. *J. Res. Punjab Agric. Univ., Ludhiana*. 11 (2) : 191-196.
- Toor, H.S. and Ramzan, M. 1974b. Extent of losses to sunflower due to rose ringed parakeet, *Psittacula krameri* (Scopoli) at Ludhiana (Pb.) *J. Res. Punjab agric. Univ. Ludhiana*, 11 (2) : 197-199.
- Toor, H.S. and Ramzan, M. 1974c. A study on grapes pest of birds. *Punjab Hort J.* 14 (1 & 2) 46-48.
- Toor, H.S. and Sandhu, P. S. 1979. Note on bird pests of grapes. by the house-crow to wheat Seedlings at Ludhiana. *Indian J. agric. Sci.*, 49 (10) : 817
- Toor, H.S. and Sandhu, 1980. Seasonal and diurnal fluctuations in the population of bird fauna on the natural vegetation in the vicinity of Halwara Airfield. *Indian J. Ecol.*, 7 (1): 18-28.
- Toor, H.S. and Sandhu, P.S. 1981. An estimation of bird damage to Peach, *Prunus persica* Batsch. *Indian J. Ecol.*, 8 (2) : 308-310.

A SYSTEMATIC APPROACH TO BIRD PEST MANAGEMENT

P.S. SANDHU AND H. S. TOOR*

Introduction:

There are about 8,600 species of birds in the world. Of these, Indian avifauna is represented by 2,060 species and sub-species. Most of the birds are closely associated with our day-to-day life due to their (a) aesthetic value, (b) food value (c) role in the pollination and dispersal of some economically important plants and (d) help rendered in consuming a large amount of insects and rodents injurious to cultivated crops. On the other hand, there are some birds which cause a considerable damage to cereal crops and fruits. Mehrotra and Bhatnagar (1979) have listed 143 bird species and sub-species which depredate various crops in India. Though a lot of work has been carried out on the taxonomic aspect, no comprehensive account of food, feeding, breeding and roosting ecology of the common bird depredators is available that may be utilized for assigning exact economic status to them and the subsequent evolution of management strategies wherever necessary.

This paper deals with the systematic approach to the bird pest management, which involves correct identification of the depredator, knowing its exact economic status by drawing a balance sheet of its useful and harmful activities, breeding ecology and population estimates which are necessary pre requisites for evolving effective and economical control measures.

Identifying the real depredator:

The first and foremost step towards management is to sort out the bird species actually involved in crop depredations. In some situations the identity of the depredator is already known to the farmer or it can be easily established as in the case of parakeets. But in situations where large number of birds, and that too of different species are invol-

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ved, it needs very careful scrutiny of the situations so as to distinguish the real culprit (s) because some birds which enter a field may be interested in (a) weeds (b) insects on the crop or (c) grains which have fallen from the ears and are a waste for us.

To study the economic status of the depredator:

After identifying the real trouble maker, next step is to establish its economic status in the ecosystem. To achieve this, we should conduct in depth studies on the following biological aspects and record its useful or harmful activities and then draw a balance-sheet.

Food and feeding habits:

This involves the study of gut contents, food preference and feeding behaviour of the birds in the field and losses they cause to various crops.

Gut content analysis:

A large number of birds should be collected from different agro-climatic zones for at least one year. Both qualitative as well as quantitative analysis of the gut contents should be made in order to know the different food items, viz, cereal grains, weed seeds, insect matter etc. Analysis of the gut contents of the nestlings is also very essential because most of the grainivorous birds feed their nestlings with soft insects and insect larvae usually injurious to our crops. And this activity of the otherwise crop depredators may tilt the balance of their activities towards usefulness. But before passing our judgement we must study the quantity as well as quality of the insect matter devoured by the depredators, i.e. how much they feed on an insect species and what is the status of that insect in relation to agriculture.

Another thing which may prove useful at the management stage is to collect information regarding any other insectivorous bird in the area feeding on the same harmful insects devoured by the depredator bird. Because if we select population reduction strategy for the depredator bird, there can be a spurt in the insect population. And to check that increase in insect population such insectivorous birds can be of much help.

Observation of food and feeding habits in the field:

Results obtained through the gut content analysis may sometimes be very misleading. If the cultivated grains form much part of the food than the weed seeds and the insect matter, we may brand

the bird as a pest. But most of the grains obtained from its gut may be those which had fallen from the plants and are already wasted. For example in Punjab, doves and seldom feed on the standing crops. Even then their crops may be full of grains collected from the ground. So, in order to get more accurate information regarding the food and feeding habits of birds, we must observe them feeding in the fields. We should see:

which food items (cereals, fruits, weeds, etc.) are available in an area in a particular part of the year.

which food is preferred by different birds, which may be due to: (i) easiness to get (ii) more nutritive value (iii) natural food is in short supply (iv) natural food is abundant but unavailable to the birds and (v) competition with other dominant species has forced it to feed on a particular crop.

which bird causes what sort of damage and at what stage of a crop.

In most bird species size of the population, migration and breeding seasonality depend on the food supply. The distribution and intensity of crop losses also depend on the availability of the natural foods (Ward, 1965). In the situations where crops are preferred to the abundant natural food, scaring methods can be helpful in reducing bird losses to crops or fruits, but where alternative natural food is not available, scaring will also be a failure.

Feeding behaviour studies of the depredator birds should be conducted in parallel to the 'gut content studies'. Birds cause more damage when feeding in flocks and this behaviour should be studied in relation to season, weather and geography of the area. The techniques employed by various birds in different situations should also be studied. Parakeets scarcely damage inside a wheat or a barley field. They mostly take away ears from outer rows of the crop. So, by treating such crops on side we can save them from damage. They also prefer to feed directly from the plants and do not feed on the poison-or stupefying baits. Thus this behaviour helps us to recommend suitable control measures against parakeets.

Estimation of crop losses:

Assessment of losses to various crops by different depredators is very essential to know:

their impact on the crop

intensity of damage at which control measures should be started.

extent upto which expenditure incurred on control measures is justified.

effectiveness of control measures.

So far no substantial work has been done on standardizing the techniques of assessing bird damage to various crops. The few available works include Dawson (1970) on wheat, Dolbeer (1975) on sunflower and Granett *et al.* (1974) on corn. As a result we cannot get true picture of the crop losses due to birds.

For getting good results, standardized estimation methods should be used in all situations otherwise it will not be possible to compare the impact in different situations and regions. Random samples, of sufficient size and covering wide area should be taken. For example bird damage will be more near the roosting and resting places of birds. Also the damage may be more in early or late sown crops and the samples taken only from such areas will exaggerate the percentage damage. Relative number of the birds involved should also be recorded. Compensatory growth exhibited by the remaining grains should be assessed. Dawson (1970) investigated compensatory growth in wheat and concluded that it occurs only if the grains are removed at the early milky stages and even then it accounts for only about a quarter of the weight of the lost grains. Further studies are required in wheat as well as other crops and fruits. We may need different techniques for different crops or fruits. In case of fruits of peach, guava, ber, etc., even the slightest damage will render the fruit for marketing and is a total loss. On the other hand, in case of wheat, rice, maize etc., whatever grains are left in the ear/cob can be marketed. In such situations samples should be graded on the basis of the percentage loss to the ear/cob and then overall damage calculated. In case of fruit trees we should take samples from different canopies and sides of the trees because the damage may be more on the easily approachable parts of the plant. Toor and Sandhu (1981) have reported that parakeets and house crows damaged 61.1% fruits in the upper canopy of the peach trees as compared to 5.3% on the lower branches. Similarly Sandhu and Dhindsa (1982) recorded parakeets to cause 11.76% damage on upper branches and 1.83% on lower branches in almonds in Punjab.

The study of the physical characters of different varieties of crops in relation to the losses suffered by them due to birds should also be made. This will help in evolving bird resistant varieties.

Population estimation:

It is very important to know the population of various bird depredators, their relative abundance and population fluctuations during different parts of the year (due to migrations or new additions after the breeding season). This study is very essential for deciding the local population reduction strategy which can be employed successfully on the sedentary populations only and to know the quantum of reduction of the depredators' population so that losses do not exceed the economic injury level.

Roosting behaviour :

The birds which roost and feed in large flocks cause more damage than those which roost and feed in smaller groups. They also fly larger distances from their roosts and may have several 'day roosts' or secondary roosts (Ward and Zahavi, 1973) within the feeding area. These communal roosts provide a very good target for any strategy based on destruction provided (a) they are not associated with many non-target species (b) are away from the human dwellings and (c) the strategy poses lesser secondary hazards. Therefore, we should study the roosting behaviour of birds and map all the roosts in each area. The population of each roost can be estimated by counting the birds leaving the roost in the morning or returning in the evening. The feeding area covered by the birds from a single roost should also be mapped. Though it is tedious job but it is possible in case of birds like parakeets and house crows. The trees or the places preferred by various birds should also be recorded. This can be of some help in changing their roosting places by thinning the trees or suitably changing the habitat wherever possible.

Breeding ecology :

The study of the breeding ecology of birds is of utmost importance in deciding the strategy for population reduction of birds. We have to fix a clear cut target of killing the birds for population reduction by the use of killing techniques or chemosterillants so that some reduction in the overall population of the depredator is achieved. Savidge (1974) has noted that we must destroy 60-80% of the post-breeding population before the next breeding season begins, to achieve a small net gain. There is every possibility that due to the reduced levels of competition, more individuals remaining from the overwintering population will survive (Fretwell, 1972) and the result is increased potential of production the following year.

The possibility of the spurt of population of some other species having overlapping feeding habits with the species for which the population reduction strategy is deployed, cannot be ruled out. And this new depredator may prove to be even worst pest.

In many species breeding seasonality may depend on the food supply. Protein requirement may also differ in males and females especially during breeding season. So we should study through many seasons the effect of the availability of food on the number of the breeding population, clutch size, nestling success etc., so that an estimation of the natural mortality of the birds is also obtained, before resorting to the population reduction strategy.

Conclusion of economic status studies:

After collecting all the information on food, feeding, breeding, roosting and population fluctuations of the depredator, we are, now, in a position to assign it the exact economic status in the ecosystem. The depredator may fall in any of the following categories it may be useful. In this case proper surveillance of its activities should be continued. It may be useful throughout the year but harmful only during a short span as in the case of Bank myna (*Acridotheres gingianus*) in Punjab. This bird feeds on harmful insects throughout the year excepting May-June, when it feeds on grapes. Damage upto 19% on grapes by this bird in Punjab is recorded (Toor and Ramzan, 1974b). In such cases scaring techniques can be recommended. Species may be totally harmful like Roseringed parakeet whose damage upto 20.1% on guava (Ramzan and Toor, 1972), 12.4% on maize (Ramzan and Toor, 1973), 22% on sunflower (Toor and Ramzan, 1974a), 63% on mustard (Simwat and Sidhu, 1974), 32.21% on peach in the company of crows (Toor and Sandhu, 1981) and 7.33% on almonds (Sandhu and Dhindsa, 1982) has been recorded. In such cases we can resort to the extreme step of population reduction in addition to the preventive measures. Its status may be neutral e.g. the weaver birds feed on paddy, wheat, pearl millet, sorghum, etc., but they compensate their harmful activity by feeding on several harmful insects and weeds (Dhindsa, 1980). So, preventive measures should comprise the main strategy against such birds. The depredator may have harmful status in one region but useful or neutral status in some other regions, or at different times of the year.

From the foregoing account it is very clear that all the studies cannot be taken up by a few persons or small groups, because of the complexities of the avifauna and varied agro-ecosystems. Diverse groups of workers should be involved in a systematic and co-ordinated research aimed at assessing the economic status of different crop depredators and their management. The government should liberally finance and encourage the research on Economic Ornithology which is still in its infancy in India.

REFERENCES

- Dawson, D.G. Estimation of grain loss due to sparrows (*Passer domesticus*) in New Zealand. *N.Z. J. agric. Res.* 3: 681-688.
- Dhindsa, M.S. (1980). *Ecological studies on the weaver birds of the Punjab and their control*. Ph.D. dissertation (unpublished), Punjab Agricultural University, Ludhiana.
- Dolbeer, R.A. (1975). A comparison of two methods for estimating bird damage to sunflower. *J. Wildl. Manage.* 39: 802-806.
- Fretwell, S.D. (1972). *Populations in a seasonal environment*, Monographs in Population Biology, No. 5, xxiii+217 pp. Princeton, New Jersey: Princeton University Press.
- Granett, P., Trout, J.R., Messersmith, D.N. and Stockdale, T.M. (1974). Sampling corn for bird damage. *J. Wildl. Manage.* 38:903-909.
- Mehrotra, K.N. and Bhatnagar, R.K. (1979). *Status of Economic Ornithology in India*. Indian Council of Agricultural Research, New Delhi. pp 79.
- Ramzan, M. and Toor, H.S. 1972. Studies on guava fruit due to Rose-ringed parakeet, *Psittacula krameri* (Scopoli) at Ludhiana (Pb.) *Punjab Hort. J.* 12:144-145.
- Ramzan, M. and Toor, H.S. 1973. Damage to maize crop by rose-ringed parakeet, *Psittacula krameri* (Scopoli) in the Punjab. *J. Bombay nat Hist. Soc.* 70:201-204.
- Sandhu, P.S. and Dhindsa, M.S. (1982). Rose-ringed parakeet damage to almonds at Ludhiana in Punjab with notes on some other animal pests. *Indian J. agric. Sci.* 52:(10): (Accepted)
- Savidge, I.R. (1974). A model for management predictions to territorial bird population. *Ohio J. Sci.* 74:301-312.
- Simwat, G.S. and Sidhu, A.S. (1974). Food preference of the rose-ringed parakeet Indian. *J. agric. Sci.* 44:304-305.
- Toor, H.S. and Ramzan, M. (1974a). Extent of losses to sunflower due to rose-ringed parakeet, *Psittacula krameri* (Scopoli) at Ludhiana (Pb.) *J. Res., Punjab agric Univ.* 13:197-199.

- Toor, H.S. and Ramzan, M. (1974b). A study on grapes loss to birds. *Punjab Hort. J.* 14: 46-48.
- Toor, H.S. and Sandhu, P.S. (1981). An estimation of bird damage to Peach, *Prunus persica* Batsch. *Indian J. Ecol.* 8:308-310.
- Ward, P. (1965). Feeding ecology of the black-faced dioch *Quelea quelea* in Nigeria. *Ibis.* 107:173-214.
- Ward, P. and Zahavi, A. 1973. The importance of certain assemblages of birds as 'information centres' for food-finding. *Ibis.* 115:517-534.

THE ROSERINGED PARAKEET THE PROBLEM BIRD IN AGRICULTURE AND ITS MANAGEMENT

N. SHIVANARAYAN*

Among various avian depredators of crops in India, Roseringed Parakeet (*Psittacula krameri*), because of its ubiquitous abundance and flock feeding habit, is considered to be the most destructive bird to agriculture. According to Salim Ali & Ripley (1969), "Parakeets are highly destructive bird pests with no compensating virtue from the economic point of view". However, the importance and seriousness of this statement has not been realised due to lack of our understanding on the magnitude of the damage these birds cause and consequently little effort has been made to evolve a suitable management programme. For the management programme of such an economically important bird, it is pertinent to consider feeding habits of the species to evolve effective and practical means of pest management. I, therefore, present here these aspects of Roseringed Parakeet and certain control technology that can be adopted to reduce the level of damage.

Distribution

Roseringed Parakeet is the most widely distributed species of all parrots. The species occurs in Central and North-Eastern Africa, Afghanistan, Pakistan, India, Nepal, Central Burma and Ceylon. It is an introduced species in Mauritius, Zanzibar, Egypt, Aden, Oman, Kuwait, Iraq, Iran, Hongkong, Macao and Singapore. Recently Roseringed Parakeet having escaped from captivity, has established a successful feral population and is becoming widespread in London suburbs. They are reported to be effectively breeding in these parts and causing damage to ripening fruits. In India, Roseringed Parakeets are abundantly seen in deciduous woodlands, light secondary jungle, semi-desert scrable and in gardens, orchards and cultivated farmlands in the neighbourhood of human habitations (Ali and Ripley, 1969).

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Feeding behaviour

A review on the feeding habit of Roseringed Parakeets shows that they feed on seeds, berries, fruits, blossoms and nectar and are serious pests in orchards, coffee plantations and crop lands (Ali and Abdul Ali, 1939). Around Bombay these parrots bite off petals of *Erythrina* and *Salmaal* to get at nectar (Wilson, 1942). In Sudan damage to crops is not widespread, being confined mainly to areas where crop lands adjoining patches of forest are inhabited by the birds. Crop contents of Roseringed Parakeets collected near Fika, Nigeria comprised *Fiscus* fruits seeds and millet grains (Benner Man, 1951), Ali & Ripley (1969), described the food of Roseringed Parakeet as fruits, cereal grain and seeds of all kinds, wild as well as cultivated. Toor and Ramzan (1974-a) analysed gut contents from parakeets collected from Ludhiana (Punjab), North Western part of India and found that they caused significant damage to guavas (*Psidium guajava*), and crops like maize, sunflower, wheat and groundnut. Among native fruits, *Dalbergiasissoo*, *Ficus* and *Acacia* species, *Melia azedarach*, *Azadirachta indica* and *Albezia lebbek* were recorded from its gut contents.

Further observations on the feeding habits of the bird were undertaken at Andhra Pradesh Agricultural University Hyderabad to have an in depth knowledge of the food habit and its economic status in relation to agriculture. Observations carried out from dawn to dusk in the cultivated lands, indicate that parrots adhere to a rather strict feeding time. The parrots reach the feeding areas at dawn and feed for 2—3 hours (normally 6. a.m. to 9. a.m.) and the second feeding session begins by about 4.00 p.m. and lasts for 1½ to 2 hours after which they fly to night roost. The depredation by parakeets, commences when the grains reach milky stage and continues till late dough stage or harvest.

Crop contents of 166 adult parakeets collected from an agricultural area were analysed and are given in Table 1.

It is seen that the Roseringed Parakeet feeds on various kinds of plant foods among which cereals, oilseeds and pulses formed the major regularly occurring food items. Rice (*Oryza sativa*) and Sorghum (*Sorghum bicolor*) appeared to be the most preferred cereal as these grains were recorded in the crop almost throughout the year. Sunflower (*Helianthus annuus*) also formed a predominant source of food for parakeet. Dehusked seeds of sunflower were present in the crop in large numbers. Safflower (*Carthamus tinctorius*) Gingelly (*Sesamum indicum*)

seeds and groundnut (*Arachis hypogaea*) were the other oilseed crops recorded. However, the occurrence of these food items was less common. Besides cereals and oilseeds the parakeet consumed large quantities of Bengal gram, (*Cicer arietinum*), (*Cajanus cajan*) Redgram and Blackgram (*Phaseolous mungo*). Seeds of the common weed, *Celosia argentea* were recorded from the birds collected in May, June and October. This

Table 1. Crop analysis of Roseringed Parakeet collected from Hyderabad during September-1975 and August-1977.

Month	No. of birds dissected	Crop contents
September	5	Sunflower, sorghum, blackgram, Guava
October	8	Sorghum, Redgram, Rice, Gingelly seeds, weeds.
November	5	Sunflower, sorghum, Rice, Maize.
December	10	Sunflower, Sorghum, Rice, Guava, Goundnut
January	5	Sunflower, Rice, Redgram, Bengalgram, Guava
February	9	Safflower, Rice, Guava, Redgram.
March	5	Sunflower, Sorghum. Maize, Blackgram, Redgram, Rice, Bengalgram.
April	20	Sunflower, Maize, Rice, Redgram, Blackgram Guava.
May	45	Sunflower, Maize, Blackgram, Bengalgram, Sorghum, Weeds, Rice.
June	20	Sunflower, Sorghum, Rice, Redgram, Bengalgram, weeds, Seeds.
July	22	Sunflower, Sorghum, Blackgram, Rice, Guava.
August	12	Sunflower, Sorghum, Blackgram, Greengram, Guava.

familiar weed is generally found growing in profusion on the borders in the cropped area or at times, when not weeded out within the crop itself. In the study are the seeds of *C. argentea* are available for birds to feed from October onwards till the end of June. In certain birds, seeds and pulp of guava were also observed.

It has not been possible to determine the food preference in parakeet in the field, but based on the food items present in the crop during the various months and classifying them into three important classes such as cereal grains, oilseeds and pulses. It is seen in Table 2 that of the 166 birds examined, cereals were present in 96 individuals (57.83%) while 61 birds (36.74%) had oilseed and 51 birds (30.72%) pulses in their crops.

The parakeet also feeds on native fruits of *Pongaemia glabra*, *Poltoforum ferrugenum*, *Albezzia lebbek*, *Ficus*, *Prosopis Spp.* and *Casia siamia* and *Acacia arabica*.

Food in the Nestlings :

Table 2. Crop contents of 40 nestlings of Roseringed Parakeet

Food type	Kind of seeds	Frequency of seed occurrence (No. of crops).
Pulses	Bengal gram	15
	Green gram	23
	Red gram	14
	Black gram	18
Cereals	Sorghum	2
	Maize	3
	Rice	8
Oil seeds	Sunflower	4
	Safflower	6
Miscellaneous	Anthers (Maize)	18
	Bark	18

From the above Table, it is apparent that the food in nestlings of Roseringed Parakeet, as in adult comprises of pulses, oilseeds and cereals. Red gram Green gram, Black gram. Bengal gram form the source of pulses while Sunflower and Safflower are the two oil-seeds in

the crops of nestlings. The cereal grains in the food items were Rice and Maize. In some nestlings anthers of maize and pieces of tree bark are also found. The nutritive value of anthers and tree bark is not exactly known. It is seen that pulses formed the major part of the food consumed by nestlings. The crop analysis of nestlings have shown that there is not much difference in food consumption between adult and nestling of Roseringed Parakeet.

Loss infilted to crops by Parakeets :

Loss to various crops by parakeets is not assessable as more than one species of bird pest is involved in depradation. However, in sun flower, parakeets alone are recorded as the major pest the damage is found to be about 60% in cultivators fields. In small experimental fields of 50 per cent or less, the loss can be 75% or more on head basis. In Punjab Agricultural University, Ludhiana, sunflower suffered a loss of 22% in the experimental plot (Toor and Ramzan, 1974 b).

Food intake :

Table 3. Average daily food consumption in Roseringed Parakeet

Monthly	Food items consumed in grams			
	1975-76		1976-77	
	Sunflower	Sunflower	Paddy	Sorghum
September	13.35	14.51	3.42	3.33
October	15.05	9.34	2.11	1.23
November	16.34	11.88	1.63	1.73
December	15.14	14.32	1.81	1.63
January	14.68	12.21	2.15	1.20
February	14.60	15.18	1.99	1.73
March	9.72	8.23	1.04	0.91
April	9.51	6.77	0.60	0.41
May	10.09	11.60	0.81	0.55
June	10.45	11.50	0.74	0.57
July	13.12	9.01	1.44	1.21
August	12.35	16.56	1.14	0.76
Average for 12 months	12.86	11.76	1.57	1.27

Under captive conditions, a parakeet consumed 9.51 to 16.34g (average 12.86g) of sunflower a day. This hypothetically means that a parakeet consumes about 390g of sunflower in a month. When given along with paddy and sorghum, the average consumption of sunflower in a day is 11.76 g while that of paddy and sorghum are 1.51 g and 1.27g a day. Studies indicate that parakeet has a preference for sunflower, when present, amongst the other economically important food sources.

Control strategies

The studies conducted both at Punjab and Hyderabad and the available information on the feeding habit of Roseringed Parakeet indicate that the bird is totally destructive to agriculture and methods to alleviate damage are warranted. Although traditional scaring devices like human yelling, beating empty tins, pelting stones, etc. are in vogue in the country, these methods have not brought about the required effects mainly because the birds learn to ignore these devices and continue feeding.

The current practices in bird pest management include population regulation through lethal control, habitat or biotope manipulation, chemical control (Repellents and toxic baits) and various scaring techniques. Among these methods first consideration must be given to those strategies which involve minimal ecological impact.

In addition to existing traditional scaring devices for crop protection from parakeets, the following methods will also be useful for the control of Roseringed Parakeet.

Auditory repellents :—Birds perceive loud explosions created by shotguns and carbide exploders and find them noxious. Parakeets can be effectively and economically made to move from cropped areas by firing a 0.22 rifle above the birds. This will flush the feeding flock. Similarly use of 12 Bore shotgun shell covering a powerful fire-cracker instead of shot is also an effective means of scaring flocks of parakeets.

Carbide gun (acetylene gas exploder) is another scaring device which produces much louder sound than a shotgun blast. The location of the exploder and the frequency of blast in the field should be changed from time to time, so that the birds do not become accustomed to them quickly. Mounting of the exploder on a stand above the crop gives the best deterrent effect. A small thin steel drum with the ends removed

and fixed just beyond the barrel of exploder enables the drum to serve as amplifier and increases effectiveness.

The use of 'glues' on tree branches or artificial perches as a means to capture or repel depredating birds is a traditional practice followed in many countries. Stakes pasted with bird glue are placed in the fields with coated ends protruding above the plants. Parakeets visiting the cropped areas when perched on these stakes can be captured and damage prevented. Ropes, instead of stakes can also be tried in four corners and passing through the centre of the plot for capturing parakeets. The method should be repeated till the parakeets learn to avoid plots containing stakes or ropes.

In India, Roseringed Parakeet can be regarded as the most destructive and perhaps the most numerous of main pest species. Because of its flock feeding habit and occurrence of large roosting colonies, one tends to think of a population check of the species so that in the years to come we do not have a situation similar to *Quelea* problem of Africa. The idea of population reduction of Roseringed Parakeet may meet with criticism from conservationists and human societies but in the absence of an effective crop protection device, attempts to reduce the population should be made, the effect of which may be seen in the long run. The eggs of the parakeet may be removed from the nest holes to avoid any direct killing of the bird. Efforts may also be made to plug the nest holes in localities where the parakeets have large breeding colonies. By making the breeding sites less favourable, the birds can be pushed out of places where they are not desired.

It may be said here that the dietary habits and preferences of the Roseringed Parakeet must be studied in different ecological regions and an integrated spectrum of crop protective measures be recommended. In the long run, if the pest species do not have any economical value in respect of its relationship to agriculture, efforts must be made to have a population check in the locality.

REFERENCES

1. Ali S., and Abdul Ali, H. 1938. The birds of Bombay and Salsette, Part IV, *J. Bombay nat. Hist. Soc.* 40 : 148-173.
2. Ali, S., and Ripley, S.D. 1969. *Handbook of the Birds of India and Pakistan*, Vol. 3, Bombay : Oxford University Press.

3. Banner Man, D.A. 1951. The Birds of Tropical West Africa, Vol. 8, Edinburgh : Oliver and Boyd. pp ?
4. Toor, H.S., and Ramzan, M. 1974a. Seasonal food and feeding habits of the birds of the Punjab J. Res., II (2), 191-196.
5. Toor, H.S. and Ramzan, M. 1974b. The extent of losses to sunflower due to Roseringed Parakeet *Psittacula krameri* (Scopoli) at Ludhiana (Punjab) Punjab J. Res., II (2) 197-9.
6. Wilson, C.E. 1979. Birds causing crop damage in the Sudan, Sudan Notes Rec., 29, 161-73.

A STUDY OF BREEDING BIOLOGY OF *PSITTACULA KRAMERI*

A. K. SINGH AND P. KUMAR

Introduction:

Psittacula krameri is one of the most destructive avian species to Indian agriculture. Unfortunately so far no practical control approach is available so as to reduce losses due to this species. For development of control technology, studies on biology are warranted with which it would be possible to have rational decisions on control measures (Edwards, 1968). With these backgrounds, studies were undertaken.

A few workers namely, Lamba (1966) and Simwat & Sidhu (1973) have studied nidification of this parakeet. However, detailed information on the biology of this parakeet is wanting. A description of rose ringed parakeet's breeding in Surrey was described by Forster (1970). Smith (1972) has described the reproduction behaviour, rate of growth, nesting and nestling development in captivity in England.

Materials and Methods:

The study on nidification and breeding behaviour was undertaken in the campus of Lucknow University in 1979. For this study, 20 nests on different trees of 'Ashok' and foliage-rich trees were located in the campus of Lucknow University. The location of nest holes on different trees and the materials used for the formation of nests were recorded. A pair of binoculars, 8x30, search lights and torches were used for the study of nests and their construction. The clutch size, incubation period, appearance of rectrices and remiges, the feeding of fledglings by their parents and nesting success were recorded during February to April, 1979. The number and size of eggs laid, their fertility and hatching dates, development and mortality of fledglings were also recorded.

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The paper was taken as read

Results:

In Lucknow University campus, Jamma Masjid, Hasanganj, Residential, buildings behind Bara Imambara and Chowk Area are probably principal roosting place of *P. krameri* because their presence have been observed on these sites throughout the year. Their nests have been located on Jamun (*Syzygium cumini*), Peepal (*Ficus religiosa*), Fig (*Ficus carica*), Kathal (*Artocarpus communis*), Mango (*Mangifera indica*), Ashok (*Polyalthia longifolia*) and Neem (*Azadirachta indica*).

With the formation of pairs at the start of breeding season, the number of parakeets reduce at roosting sites. In courtship behaviour the pairs were observed to perch together and female spreads her wings a little, moved her head in a half moon shape, uttering a low twittering call and joined her bill to partners bill. The copulation action of several pairs was observed on trees, house tops, etc. generally after feeding trips. The copulation lasted for about a minute or so.

Generally, birds used a natural deep hollow portion of different kinds of trees as their nest. The nest holes were circular (diameter, 3.5-5 inches). The chambers in hollow portions of trees were quite spacious to house adult parakeets and fledglings. Few chips of wood and debris were found in the nests.

After 6-9 days of occupation of nest the female started laying egg. The interval between the laying of two eggs was 24 to 48 hours. The clutch size varied from two to five eggs.

The eggs were snow white, broad, oval in shape and not sharply pointed towards the narrow end. Eggs measured 31-33 mm in length (Average 31.9 mm) and 23-25 mm in breadth (average 23.5 mm) when 26 eggs were examined. The nest sites were carefully guarded. They restricted their territory upto the nest holes and were monogamous.

The incubation period varied from 22-24 days (average 22.6 days). The rate of fertility of the eggs appear to be very high, i.e. 87.88%. Of 66 eggs laid in 20 nests, 58 eggs hatched.

The brooding started just after the hatching of the first egg laid. Both sexes participated in brooding. The pollen grains, fruits and

grains constituted the bulk of the food for fledglings. The fledglings left the nest when they were about six weeks old. The unhatched eggs remained in the nest. The total nesting period varied from 9 to 10 weeks.

The freshly hatched fledglings were nidicolous i.e. naked. Their eyes were closed, hard beak with greyish tip and claws were soft and light flesh coloured like rest of the body. A few neossoptiles and the egg tooth could be seen. The newly hatched young were unable to raise their neck for food. The eyes opened after 5-6 days of hatching. The colour of the body turned whitish after 3-4 days. The number of grey neossoptiles increased and were replaced by green teleoptiles after about seven days. After about 10 days, wing and tail feathers developed in the form of gramophone needle-like structures. Three weeks old fledglings could utilize the food material by themselves. The chicks were almost fully fledged in about 28 days. Fledglings resembled adults except in the body size and absence of rose ring in the males and presence of dark iris instead of white. The feathers of wings were dark colored and the feathers on body were green. Tail feathers were bluish. The bill was coral red above and feet, grey.

The mortality of young appeared to be very low. Out of 58 fledglings that hatched out only 13 fledglings (22.41%) died probably due to natural agents. The dead fledglings were thrown out of the nest by parents.

Of 66 eggs laid in 20 nests, 58 eggs hatched but only 45 fledglings survived. On an average the nesting success was 68.18%.

Discussion

The entire campus of the University of Lucknow is a roosting place of *P. krameri*. In the evening, between 6.30 and 7.00 P.M., thousands of parakeets fly into the campus and roost in the 'Ashok' trees. They fly between 5 to 6 A.M. for foraging, which, if on economic crops become pestilent.

P. krameri is a monogamous bird but Hume (1873) reported two females sharing single nest. The breeding season has been recorded from February to April in Lucknow. The same period is also reported in other places of Northern India by Barnes (1886), Currie (1916), Reid (1881) and Whistler (1930). The period of breeding varies from place to

place in India. It is from May to June in Himalayan foot hills (Field, 1922); from December to April in South India and Deccan (Ali, 1953, Baker and Inglis, 1930, Davidson and Wendan, 1878 and Taylor, 1887). Breeding season starts early in South India. The parakeets are remarkably uniform in nesting habits. Holes already formed by woodpeckers, barbets, etc. in trees may be enlarged and deepened by parakeets for use. In rare cases, if suitable nest is not available, the pair selects a soft wooded tree and dig the nest hole three months before egg laying (Butler, 1875). Sometimes they occupy the nest of squirrels (Dewar, 1909 and Currie, 1916 b). The parakeets often select a hole or hollow portion of the outer wall of buildings near human habitation as their nests. The female lays her eggs on bare wood or chips of wood and debris or plaster according to the position of its nest site.

The 'territory' is of mating, nesting and feeding type (Mayr, 1935 and Nice, 1941). The nesting success depends on predators, disease and natural calamities. A high nesting success of 68.18% ensures sufficient population in the next generation to become pestilent. In addition some adult parakeets perish. In this way, some balance in its population is maintained in nature.

After a heavy hail storm and rains, thousands of dead parakeets with their fledglings and many pieces of broken egg shells were found in the University campus of Lucknow in 1980.

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REFERENCES

- Ali, S. 1953. *The birds of Travancore and Cochin*. Oxford University Press, Bombay.
- Barnes, H.E. 1886. Birds nesting in Rajputana. *J. Bombay nat. Hist. Soc.* 1 (2) : 38-62.
- Baker, H.R. and Inglis, C.M. 1930. *The birds of Southern India*. Govt. Press, Madras.
- Butler, A.E. 1875. Notes on the avifauna of Mount Abu and northern Gujarat. 1. *Str. Feath.* 3 : 437-500.

- Currie, A.J. 1916 a. The birds of Lahore and vicinity. *J. Bombay nat. Hist. Soc.*, 24 : 561-577.
- Currie, A.J. 1916b. Unusual nesting sites. *J. Bombay nat. Hist. Soc.*, 24 : 600-601.
- Davidson, C.S. and Wendan, C.E. 1878. A contribution to the avifauna of Deccan. *Str. Feath.* 7 : 68-95.
- Dewar, D. 1909. Birds of the plains. John Lane the Bodley, Head, London.
- Field, F. 1982. Rough list and notes on the birds found breeding in the Gonda district. *J. Bombay nat. Hist. Soc.*, 28 : 753-772.
- Forster, R.H.B. 1970. Rose ringed parakeets breeding in Surrey. *Q. Bull Surrey Bird club* No. 59 : 20-21.
- Hume, A.O., 1873. Nests and eggs of Indian birds. Rough draft. Supd. Govt. Btg., Calcutta.

DAMAGE TO MAIZE AND GUAVA CROPS

BY

PSITTACULA KRAMERI

A.K. SINGH AND P. KUMAR

Introduction:

A preliminary assessment of losses to maize and guava caused by *Psittacula krameri* has been made by Ramzan & Toor (1971, 1973) and Simwat and Sidhu (1973). The present study was undertaken to quantify the loss caused by this species to these crops.

Materials and Methods:

Maize (*Zea mays*)

The study area for evaluating damage to maize crop caused by *P. krameri* comprised two fields, each of one acre, in a village Berga, District Faizabad, U.P. One field was located about 50 metres from a mango grove, (roosting site) the other was about 300 metres away from the grove. All field observations were made during August and September.

Guava (*Psidium guajava*)

Damage to *P. guajava* was studied from the third week of October to about the last week of December, when the fruits were most abundant. An orchard, 3.5 acres having approximately three hundred trees (7' to 10' tall), in village Bastiuli, District Lucknow, U.P. was used for the observations. The fruits carried on one branch were counted and when multiplied with the number of branches yielded the total number borne by that tree. Fruits on twenty trees were estimated, in this manner. All damaged fruits were plucked daily at about 18 hours.

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Results:

The parakeets damaged 21.41 per cent *Zea mays* cobs equivalent to about 20 complete cobs/acre. In another field, 15.17 per cent cob amounting to 14 complete cobs were damaged by the parakeets.

The manner of feeding was of two types. First, in a circular manner, and second in a longitudinal manner. It was observed that a few cobs were fully damaged by parakeets though they were in less number. They consumed the endosperm together with the embryo leaving behind the maize grain wall (carbopsis, which is morphologically the pericarp united with the testes).

On an average, of 93.5 cobs per line in the field adjacent to the grove, 50.9 cobs were untouched by parakeets while 42.6 cobs were attacked in which 4.6, 7.2, 12.7, 10.7 cobs were damaged to the extent of 100%, 75%, 50%, 25%, and 12.5%, respectively.

Loss as damaged cobs per line in both fields and total number of fully damaged cobs was obtained by adding figures on percent frequency damage, i.e. 12.5%, 25.0%, 50% and 100%.

Percentage loss to maize cobs ranged from 37.62-54.65%, average being 45.71% in the field located adjacent to grove. In the field located away from grove, per cent loss ranged from 31.91-46.07%, average being 38.13%. Actual average loss ranged between 21.41% and 15.17%, respectively in the field adjoining the grove and in the field away from the grove.

The weight of the normal healthy guava fruits were taken which ranged from 50-400 gms. The mode of feeding observed in respect of these fruits was of two types.

1. They just picked one fruit and then flew to the other. This type of feeding is initial feeding.
2. Generally, *P. krameri* consumed 75%, 50%, 25% or less portions of a fruit, this was continuous feeding. It was very rare that they consumed complete fruits leaving behind small portion of it. The damaged fruits upto any extent in continuous feeding were unfit for marketing, resulting in complete loss of fruit but

not so in case of initial feeding. The actual loss to guava fruits ranged from 11.67-25.8% average being 19.53%.

Discussion

Damage of crops starts from setting and continues upto the time of harvesting. Parakeets are more active during morning than evening. Probably rock pigeon (*Columba livia*) affect equal damages to our economy (due to crop damage, diseases and nuisances) as parakeets (*Psittacula sp.*), followed by crows (*Corvus sp.*) and sparrows (*Passer sp.*) (Bhatnagar, 1976b).

Damage to milky corns is more severe in August than on the cobs having matured grains. The losses averaged to 12.4% (Ramzan and Toor, 1973) and 16% (Simwat and Sidhu, 1973) at Ludhiana, Punjab.

In Guava, damage by *P. krameri* are seen, both on unripe and ripe fruits but the attack on ripe fruits is severe in November and December. On an average *P. krameri* caused 19.53% loss to guava fruits (mean of 20 trees). Ramzan and Toor (1972) and Simwat and Sidhu (1973) have reported 20.07% and 30% loss to guava fruits, respectively at Ludhiana, (Punjab). They do more losses to orchard fruits than field crop grains. It is only due to involvement of higher costs in raising the orchard fruits and decrease of marketable quality (Bhatnagar, 1976b) that warrants control.

Control measures

There is no satisfactory method to control these birds but by the following methods they can be controlled to some extent.

1. Shooting or Hunting-It consists of engaging parties of trained person to shoot birds.
2. Trapping-By means of attractive food materials, nets, sticky substance as 'lassa' etc.
3. With the help of some poisons e.g. spray of five pounds DDT per acre may result in heavy mortality in parakeets, (Hotchkiss and Richard, 1946).
4. Bird scarer-Acetylene Bird scarer can help in scaring away the harmful birds.

5. Natural enemies-Natural enemies of this birds may be predators as hawks, owls, weasels, wild cats, house cats, foxes, etc.

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REFERENCES

- Bhatnagar, R.K. 1976a. Significance of bird management and control. *Pesticides*, Annual No.1976, pp. 74-83.
- Bhatnagar, R.K. 1976b. *Birds pests of agriculture and their control*. *Proc.Nat.Acad.Sci.*, India **46** (B), 1 & II: 245-256.
- Hotchkiss, N. and Richard, H.P. 1946. Effect on forest birds of DDT used for gypsy moth control in Pennsylvania. *J. Wildl. Mgt.* **10** : 202-207.
- Ramzan, M. and Toor, H.S. 1972. Studies on damage to guava fruits due to rose ringed parakeet *Psittacula krameri* (Scopoli) at Ludhiana (Pb.).
- Ramzan, M. and Toor, H.S. 1973. Damage to maize crop by rose ringed parakeet, *Psittacula krameri* (Scopoli) in the Punjab. *J. Bombay nat. Hist.Soc.* **70** (1) :201-204.
- Mehrotra, K.N. and Bhatnagar, R.K. 1979. *Status of Economic Ornithology in India*. Indian Council of Agricultural Research, New Delhi, pp.1-79.
- Simwat, G.S. and Sidhu, A.S. 1973. Studies on the feeding habits of rose ringed parakeet, *Psittacula krameri* (Scopoli). *Indian J. agric. Sci.* **43** (6) : 607-609.
- Ward, P.1975. The breeding biology of the black-faced dioch *Quelea quelea* in Nigeria. *Ibis* 107:326-349.

ECO-BIO MANAGEMENT OF BIRDS AT GRANARIES

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Introduction

Birds if not properly checked, become serious pest to stored food-grains and incur losses ranging from 10% to 20% from harvesting to flour mills. This problem has not received much attention. Pestilence of birds is particularly heavy in Rajasthan where birds are not molested and some birds as the pigeon and the peafowl are even daily fed by the local people. House sparrow, Rock pigeon are serious pests at food-grain stores and barns, and the peafowl, doves and the partridge also cause considerable losses at barns (Sharma, 1976). Pestilence of birds at various kinds of foodgrain stores, their possible environmental and biological control were studied in Jodhpur district for three years from February 1979 to late 1981.

Methodology

Pestilence to foodgrains by birds was studied at various kinds of foodgrain stores e.g., barns, farms, houses, granaries, grain markets, transport company and flour-mills sites etc., in Jodhpur city and some selected typical villages of Jodhpur district. Various measures taken by the local men and adaptations of birds to pass over these hinderances were also studied.

OBSERVATIONS AND DISCUSSIONS

Pestilence of birds

Most of the farmers stack harvested crops which largely remain uncovered for several weeks. Doves, house sparrow, partridge, pigeon and the peafowl, etc. pick foodgrains from exposed ears. It was noted

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that farmers take such pestilence lightly as they find difficult to cover widely spread harvested crop stacks.

Storing in well-covered godowns may efficiently check pestilence of birds. Godowns may be made with light and cheap materials which could be afforded by average farmers. Covering of harvested crop stacks with polythene sheets may considerably save from damage by birds as well as rain and storms. Covering of heaps with grasses or harvested crops' stem layers may also reduce bird pestilence.

At barns, thrashed grains are heavily depredated by pigeon, house sparrow, peafowl and doves, etc. These heaps should be properly covered by cloth or polythene sheets and guarded by watchman. Domestic cat if kept there, may notably scare birds away.

Storehouses and depots

At grain store-houses and depots, the pigeons and the house sparrow try to open grain-filled stacks at weak points by tearing with their beaks. From these points, grains begin to pour-out and birds get congregated to pick grains. Cutting of sacks by rats also facilitates birds, for the purpose. Considerable loss of stored grains are thus observed at open store-houses and depots where these birds can have free access.

Completely closed or narrow grill covers at grain stores and depots may effectively check invasion by birds. Keeping of the cat there may also effectively check pestilence of rats and birds. Farmers usually keep cats at their houses having granaries depots or godowns and have reported of having practically no problem of rats and birds.

During transport

During pre-and postloading times pigeon and the house sparrow considerably steal grains from the weak points at loading and unloading stations of grain stacks which remain uncovered and not guarded in trucks and railway carriages.

Grain sacks should be properly covered with polythene or canvas sheets to prevent birds to steal grains being picked from sacks.

At grain shops and markets

Grain dealers dump small heaps of foodgrains for exhibition of quality of their grains. The pigeons and sparrows depredate grains in

heavy amount from such heaps where the shop-keeper cannot easily scare invading birds by stick. Similarly in grain markets also the pigeons and the sparrows invade uncovered sacks and large grain-heaps dumped for whole-sale transactions. It was noted that the pigeons preferred jowar (*Sorghum bicolor*), wheat (*Triticum* spp.) and maize (*Zeamays*) and the sparrow preferred 'bajra', (*Penninsetum typhoides*) and rice (*Oryza sativa*).

It was also observed that some shopkeepers cover more than half area of grain heaps with cloth sheets to reduce depredations of grains by birds. On scaring, the birds move to closeby trees, roosts and transmission lines and afterwards again invade heaps of grains. Such invasion of birds runs throughout the day, more in late morning and afternoon but is less during mid-day. Covering of grains as practised by some shopkeepers should be suggested to grain merchants to reduce pestilence by birds. Suitable covering of entrances of grain shops with mesh or grill may considerably check frequent invasions of birds.

At flour-mills

At flour-mills, in 'metting rooms' the house-sparrow invades cans of grains, largely kept open much earlier before being poured into the flourmill. At many flour-mills, grains are thrashed which were not previously thrashed at homes before grinding. The pigeon and the sparrow steal grains in large quantities from such heaps under thrashing. Cans should be kept suitably covered and be opened just before pouring into the flour-mill.

At houses

For sun-drying and for control of insects and larvae foodgrains are usually spread over roofs or in courtyards. There pigeons and sparrows heavily damage by picking grains. Prompt scaring of birds or with covering thin cloth may considerably reduce* such pestilence by birds.

Measures recommended

1. Foodgrains feeding to the pigeons by local people should be discouraged as it increases breeding potential.

*Black umbrella if kept opened on spread grain layer scares sparrows & pigeon

2. Houses should have minimum number of open projections and clefts which provide rest, roost and breeding sites to the pigeon. Provision of steep slopes at projections and clefts may also discourage birds to rest, roost and breed there.

3. Keeping of the cat drastically reduces populations of the pigeons as the cat heavily preys upon adults as well as nests (clutches and broods) of the pigeon.

4. If houses and grainshops have sufficient coverage of openings of houses by grills, the pigeon and the house sparrow may not be able to invade there as 'depredators' of grains and also for breeding (nests) there and multiply.

REFERENCE

- Sharma, I.K. 1976. Ecological studies of pestilence of grain crops by birds. *Mysore J. agric. Sc.* 10 : 471-478.

SCOPE FOR ECONOMIC ORNITHOLOGICAL STUDIES IN WESTERN MAHARASHTRA*

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ABSTRACT

Birds cause a considerable damage in crop fields and orchards. Their importance as depredators has been realised now-a-days in various parts of India. The crops ravaged by birds in Western Maharashtra are jowar, wheat, bajra, maize, paddy, sunflower and fruit crops viz. pomegranate, guava, grapes, 'ber', 'chiku', mango etc. The important bird depredators are House sparrow, *Passer domesticus* (Linn.); Blue rock pigeon, *Columba livia* parakeet, *Psittacula kramari* (Scopoli); Common myna, *Acridotheres tristis* (Linn) and Baya weaver bird, *Ploceus phillipinus*. The commonly used methods by farmers for minimizing bird damage are scaring birds by using sling shots, beating drums, shouts by human beings and dummy human models (Scare Crows). So far no systematic studies on bird depredation and management have been carried out in Western Maharashtra for wants of funds though there is a dire need for it.

*Paper taken as read

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PROBLEM BIRDS OF INDIAN AGRICULTURE AND THEIR MANAGEMENT

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In number, birds are only next to fishes and upto now 8600 species belonging to 27 orders with a total number of about 300,000 subspecies have been identified (Salim Ali, 1972). According to Ripley (1961) about 2060 species occur in India. No information is available to indicate as to how many of these are pests and in what situations or regions. The losses they cause are not known as the detailed and upto date statistics are not available.

In India, farmers have known the depredating nature of birds since the beginning of Agriculture. Birds damage the crops to obtain food which results into conflict with our economic interests and poses multifarious problems all over the country. In present days with the emergence of modern agricultural practices, birds have become our competitors for food and space. They cause damage to almost all agricultural crops. Jotwani *et al.* (1969) reported that birds sometimes damage millet crops so heavily that farmers prefer to cultivate them for fodder purposes only. Bhatnagar *et al.* (1974) observed that upto 90 per cent damage was caused to different bajra varieties. Under Delhi conditions, Jotwani *et al.* (1969) reported losses upto cent per cent in *Paspalum scrobiculatum*, 13.5 percent in *Elusine coracoana* 100 per cent in *Pennisetum Typhoides*, 98.2 per cent in *Echinochloa colona*, 95.7% in *Panicum miliaceum*, 92.1 per cent in *Setaria italica*, and 75 per cent in *Panicum miliare*. Heavy damage to maturing earheads of wheat have been reported by Bhatnagar *et al.* (1973) and Srivastava and Pareek (1974). Chahal *et al.* (1973) also reported serious damage by birds to various crops.

In India, parakeets (*Psittacula* spp.), crows (*Corvus* spp.), sparrows (*Passer* spp.) and rock pigeon (*Columba livia* Gmelin) are the common

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bird species which cause serious losses to different agricultural crops and fruits at sowing, seedling and later stages of crops.

1. **Parakeets (*Psittacula* spp.):**

There are many species of parakeets in India. These extensively damage the harvest, fruits and vegetables by cutting, spillage and shattering them. They damage all types of green and ripe fruits specially mango, guava, pomegranate, apple etc. and maize, sorghum, bajra, wheat and gram in the harvest.

2. **House sparrow (*Passer domesticus*)**

There are many species of house sparrow in India. The house sparrow is found everywhere. The adult sparrow eats the grain of rice, sorghum, bajra, wheat, millets while the young ones eat the insects.

It has also been observed that if insect infested grain is kept for drying in sunlight then it catches the insects first from the grain then eats the grain.

3. **Crow (*Corvus splendens*)**

Two species of crows viz. the Domestic crow and Wild crow are common in India. The domestic crow, causes much damage to standing crops and fruits such as mango, guava, fig and mulberry in the field. They also cause serious losses to poultry as also they catch and eat small faults and eggs and eat them.

4. **Pigeon (*Columba livia*)**

Pigeons are perhaps the most serious bird pest which damage the grain and sown seeds of different crops and which also may well become the main cause of poor germination.

5. **Bulbul (*Pycnonotus cafer*):**

It gathers in large numbers wherever they get ripened fruits to eat. They are more prevalent after first showers of monsoon.

6. **Myna (*Acridotheres tristis*):**

It is largely insectivorous in nature but at times causes damage to crop seeds and fruits.

7. **Munia (*Estrilda* sp.):**

It is very small bird and is capable of removing wheat grains from earheads of wheat plants during the ripening stage of crop.

Management of problem birds:

Following methods can be employed for the management of problem birds.

1. **Physical and mechanical Methods.** Birds can be managed with limited success in problem areas scaring with noise makers and other frightening devices. Reduction in local bird population may be achieved by eliminating nesting, roosting and hiding places through the use of flame throwers and explosives. Use of nylon nets effectively checks bird's damage in crops growing in smaller areas.

2. **Cultural method :** Planting of buffer or diversionary crops to attract attention away from important cultivars is one such practice which holds great promise as the population pressure of birds gets distributed evenly on all crops. The timing of crop maturity to coincide with those of the surrounding areas is other method by which birds damage can sufficiently be checked. Timely harvesting of sugarcane lessens the bird damage in adjoining wheat fields.

3. **Search for bird resistance in different crop/varieties :** Efforts should be made to identify varieties in different crops showing low resistance to birds. Some varieties which showed consistently damage against pigeon, sparrows, parakeets are as follows:

- (i) Bajra : MBH-110, MH-88, MH-38, PHB-14.
- (ii) Sorghum : Bird-Go, AKS-614, GA-615, S-Girl-MR-1, BR-60.
- (iii) Wheat : S-1982, Sonalika, Np-710.
- (iv) Paddy : C. 6024, MTU-3626.

The varieties and hybrids of sorghum with high tannin contents, large glumes, awned lemma, lax panicles, goose-neck earheads and brown seeds generally escapes damage by birds. Beri *et al.* (1968) reported that the bajra varieties with shed anthers and awns on earheads can withstand bird damage.

4. **Chemosterilants:** These can be utilised for population management due to lower cost, ease in applicability and their non-detection by target species. Ornitol or Azacholesterol (20, 25-diazacholesterol

dihydrochloride) and anticholesterol compound is being used for pigeon management. The recommended treatment is 3.4kg of whole corn baits for every 100 pigeons for 10 days. Baits can be prepared by impregnating the corns to make 0.1% with respect of ornitrol.

5. *Biological control.* This control method though has been very much talked about is still in preliminary phase as regards the control of birds. Man himself has been a predator of birds from ancient times. *Trichomonas gallinae*, a pathogenic protozoan has been reported on passenger pigeons. Trained falcons for scaring birds have been successfully utilised by Royal Air Force at Canada Airports but this technique has however, limited scope.

6. *Bird repellents:* Chemicals used as bird repellents are known for more than 150 years. They impart three types of repellency action viz., (i) repellency by distastefulness, (ii) repellency through physiological disorders which means that initially the birds even take distasteful grains but in later stage of feeding are unable to feed on treated seeds and (iii) repellency generated among the unaffected members of a bird population by the actions of affected members of the same population. It can be termed as psychological repellency or frightening through chemical.

Thiram when sprayed on nature grains of sorghum repelled English sparrows in Texas (Metzer and Royal, 1961) while Avitrol 100 (4-nitropyridine-N-oxide) and Avitrol 200 (4-amino-pyridine) were two other valuable substances found to repel birds (Dogget, 1970). Recently a new chemical called 'Methiocarb' was found effective in reducing the bird damage at Colorado and Oklahoma to sprouting corn and sorghum, to ripening rice and sorghum and ripening cherries and grapes (Guarino, 1971). It is broad-spectrum compound with high repellent activity to pheasants, grackles, starlings, red-winged black birds, robins and crows. Experiments are on way to find efficacy of this chemical under Indian conditions against different bird species damaging various crops and fruits.

7. *Poison Baits:* Recently poison baits have been successfully utilised for the control of birds. Malathion spray at the rate of 0.3% on seeds kill sparrows. Seeds of sorghum if treated at the rate of 5 parts actual of carbofuran S.P. in 100 parts of seeds kill the pigeons and sparrows. It also prevents digging of seeds from sown fields.

REFERENCES

- Ali, Salim. (1972). Common birds of India. *Bombay Nat. Hist. Soc. 9th Ed., I-III* +1-162.
- Beri, Y.P., M.G. Jotwani, Misra, S.S., and Chandra, D. 1968. Studies on relative bird damage to different experimental hybrid birds of bajra. *Indian J. Ent.* 31 (1) :69-71.
- Bhatnagar, R.K., Raizada, M. and Verma K.K., (1973), *Ento. Newsletter*, New Delhi. 2 (3) : 22-23.
- Bhatnagar, R.K. (1974). *Ento. Newsletter*, New Delhi, 4 (4) : 27.
- Chahal, B.S., Simwat, G.S. and Brar, H.S. (1973). *Pesticides*, 11 :34-36.
- Doggett, H. 1970. Sorghum. Longmans Green and Co. Ltd., London and Harlow.
- Guarino, J.L. 1971. Methiocarb, a chemical bird repellent. A review of its status and uses. Bureau of sport fisheries and wild life. *Wildlife Research Centre, Denver. Colorado.*
- Jotwani, M.G., Beri, Y.P. and Verma, K.K. (1969). *The Allahabad Farmer XLIII* (1) :43-44, 1 Pl.
- Metzer, R. and Royall, Jr. W.C. 1961. Field tests of three Chemicals as bird repellents on mature grain sorghum. *Texas Agri. Exp. Sta. college Station, Texas* 6 pp.
- Ripley, S.D. II (1961). *Syno. Birds India, Pakistan together with those of Nepal, Sikkim, Bhutan and Ceylon. Bombay Nat. Hist. Soc.* 1-XXXV : 1-702.
- Srivastava, R.P. and Pareek, R.P. (1974). *Ent. Newsletter*, New Delhi. 4 (9) :52.

BIRD PESTS ON SORGHUM AND THEIR MANAGEMENT*

N. SANTHAIAH**

Introduction

In India major millets like Sorghum (*Sorghum bicolor*), Bajra (*Pennisetum typhoides*) and minor millets are cultivated mostly under rainfed conditions. Of these, sorghum is one of the important millets, used as staple food. Among the factors responsible for crop losses, birds from an important factor (Dogget, 1970). In Latin America, Sorghum is damaged by a variety of birds (De Grazio and Besser, 1970). Red billed weaver, *Quelea quelea*, is reported to cause enormous damage to sorghum in Africa (Jackson, 1974; De Grazio and Besser, 1974; Park, 1974; Jackson, 1974).

In India, information on the avian pests of millets is scanty and precise damage estimates are not available for most areas. Rao and Rao (1953) reported 20 to 80 per cent loss in different sorghum varieties. Perumal et al. (1971) observed upto 83.00 per cent damage due to three species of birds. In Delhi region, Beri et al. (1971) have noticed 12.82 to 85.5 per cent damage in sorghum due to bird pests. In case of 'bajra', Jotwani et al. (1969) observed bird damage ranging from 13.50 to 100.00 per cent due to sparrow and parakeets. Bhatnagar et al. (1974) and Mehrotra and Bhatnagar (1979) reported damage to bajra ranging from 2.00 to 90.00 per cent due to sparrows, starlings, weaver birds and parakeets in the experimental fields at Delhi. Studies on the bird pests of millets and assessment of losses were taken-up at Andhra Pradesh Agricultural University, Hyderabad.

Depredatory aves of Millets

The actual damage of sorghum is observed when pigeons (*Columba*

*Paper taken as read

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livia) and doves (*Streptopelia* spp;) remove the sown seed and feed them. At milky stage Indian baya (*Ploceus philippinus*), streaked weaver bird (*P. manvar*), house sparrow (*Passer domesticus*), white throated Munia (*Lonchura malabarica*), Spotted Munia (*L. punctulata*), black headed munia (*L. malacca*), are found pressing the grains for feeding and house Crow (*Coryus splendens*). Indian myna (*Acridotheres tristis*) are also observed removing grains from the earheads. Roseringed parakeets (*Psittacula krameri manillensis*) damages the earheads of sorghum in milky stage. Sometimes a part of the earhead is clipped-off and taken away for food. Besides the above mentioned birds/Rosy paster (*Sturnus roseus*) is also observed feeding on sorghum in the cultivated fields during the Rabi season.

Assessment of damages

Assessment of damage, was taken up in cultivator fields of Kurnool district and at Nandyal. Sixty eight fields having thirty four varieties of sorghum at grain maturing stage were surveyed. Three Unit area 2x2 m were randomly selected in each field. In each plot, the total number of earheads, bird damaged earheads and undamaged earheads were counted. The extent of damage was upto 25.46 per cent in the cultivators fields and in the experimental plots the damage was 7.92 to 100.00%. It was observed that the percentage of damage depends on ecological factors and seasonal conditions. During summers, damage of 100.00 per cent in experimental plots at Nandyal was observed due to lesser cropped area and to maximum bird population stress on few crops available under irrigated conditions.

Control Measures

We have effective means of crop protection from insect pests, the bird pests are still a problem for farmers for these control measures like beating drums, yelling, pelting stones and scare-crow are in practice in the cultivators fields.

The control of bird pests damaging millets, especially sorghum undertaken in Andhra Pradesh Agricultural University, Hyderabad revealed the following :

1. *Scaring* : The methods most frequently used by farmers are yelling, beating empty drums and shouts by humans. These sounds are effective for short periods since birds usually become accustomed to them, so that continued effective use is difficult.

2. *Netting* : Small areas of crops can be protected effectively by nylon nets. However due to high cost of nylon nets, it is not practicable to protect large areas.

Field trials conducted from 1974-76 at Rajendranagar showed that the yield in a sorghum plot fully protected with nylon net of 9.5 per cent was 20 kg as against 8 kg. in the equivalent plot without bird scaring. Thus the loss in yield due to bird pests was 60%.

In the case of plots exposed methods of scaring such as yelling and shouts by human beings damage ranged 5.23% to 29.12%. Plots exposed without scaring received damage from 42.01% to 98.23%.

3. *Chemical/sprays dusts* : Efficacy of methiocarb, a chemical repellent on damaging crops in the United States has been reported (De Haven, *et al.* 1971 and Guarino, 1972). With this background, experiments were conducted with methiocarb and other chemicals to determine if birds could be repelled from feeding on ripening sorghum. The chemicals tested were : Methiocarb @ 3 kgs ai/500 litres/ha, Endosulphan 0.1% spray, BHC 0.15% spray 10% dust, Dimethoate 0.1% spray, Carbaryl 0.15% dust, Thiram @ 3 kg ai/800 litres/ha; Curb @ 10 kg/ha ; 40 kg/450 l/ha and Neem Cake Broth 50 kg/litre. Fish oil Resin Soap 5g/l ; Malthion 0.15% spray and Sevimol 0.2% spray.

It was found that none of the above chemicals were effective in protecting sorghum from bird damage.

4. *Toxic baits* : Toxic baits prepared by treating 'bajra,' paddy and sorghum grains with methiocarb at 1.0% concentration (1980-81) and diluted with 4 parts of respective grains are placed at six equidistant points in the sorghum field during milky stage. However, there was no effect of these chemicals on birds damaging sorghum.

5. *Acoustic methods* : The distress calls of parakeets and baya were replayed in sorghum field to disperse bird pests damaging the crop. Parakeets, bayas and other passerine birds dispersed for three days and afterwards they were accustomed to their distress calls. However, it was observed that the migratory rosy pastors were repelled immediately after hearing the distress calls of the parakeets for four days. Experiments with carbide gun showed that birds become accustomed to the sounds within a short period.

6. *Cultural practices* : In sorghum, Aldrich (1962) and Nickaus (1966) observed that grains with higher tannin contents and sharp awn afford protection from bird damage. It was observed, that tall and white varieties are more susceptible than the tall yellow, dwarf white and awned white varieties of sorghum.

Conclusion

Methiocarb and Curb which are effective in foreign countries, have not shown much effect in repelling bird pests. However this requires a more intensive study. Acoustic methods may be useful for short periods within the audible range of area due to the problem of habituating. Studies of varietal susceptibility have shown less damage for dwarf and awned varieties, which may prove useful.

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REFERENCES

1. Aldrich, D.J. Jr., 1962. People, pests and some plants. 213-226. In *Proc. Vertebrate Pest Control Conf.* National Pest control ASS, Elizabeth, New York.
2. Beri, Y.P., Jotwani, M.G. Srivastava, B.G., (1971). Screening of sorghum varieties against bird damage. *Entomol. Newsletter*, New Delhi, Vol.2 (5) 38.
3. Bhatnagar, R.K., Raizada, M., and Verma K.K., 1974. Screening of bajra varieties for relating damage due to birds. *Entomologist Newsletter*, 4, (10). 55.
4. De Haven, R.W., Guarina, J.L., Crase, F.T. and Schafer, E.W. Jr. 1971. Methiocarb for repelling blackbirds from ripening rice. *Int. Rice Com. Newsletter*. 20 : 25-30.
5. De Grazio, J.W. and J.F. Besser, 1970. Bird damage problems in Latin America. *Proce. 4th Vertebrate Pest Conference*, West Sacramento, Calif, March 3-5. 162-167.
6. De Grazio, J.W. and J.F. Besser, 1974. Crop and grassland seed losses : wild birds eat millions of dollars. *World Farming* 16(10).
7. Dogget, H., 1970. *Sorghum*. Longmans Green and Company Limited, London.
8. Guarino, J.L., 1972. Methiocarb, a chemical bird repellent, review of its effectiveness on crops. *proc. Vet. Pest Cont. Conf.* 5: 108-111.

- Jotwani, M.G. Beri, Y.P. and Verma, K.K., 1969. A note on bird damage to millets. *The Allahabad Farmer*, XLIII, (LQ) 43-44.
- Jackson, P.E., 1973. Susceptibility of *Quelea quelea* to Fenthion during nesting. Regional Report "Research into the control of grain eating Birds". 1-6.
- Jackson, J.J., 1974. Research into the control of grain eating birds in Africa. UNDP/SF Regional Project. "Research into the control of grain eating Birds (*Quelea quelea*)", Khartoum Base, P.O. Box 913. Khartoum (Sudan).
- Mehrotra K.N. and R.K. Bhatnagar, 1979. *Status of Economic Ornithology in India*. I.C.A.R., New Delhi, 79.
- Nichas, M.H., 1966. A Bird resistant sorghum, *Ohio Rep. Res. Dev. Biol. Agric. Home Econ.* 51 (5) : 70-71.
- Park, P.O., 1974. Granivorous birds pests in Africa, towards integrated control, *SPAN* 17 (3) : 126-128.
- Rao Priyavatha and D.V. Narsimha Rao. 1953. Bird damage in jowar. *Madras Agric. J.*, 40 ; 466-467.
- Perumal, R.S., T.R. Subramaniam and P. Leela, 1971. Studies on the birds visiting CSH-1 sorghum and the extent of damage. *Andhra Agric.* 18(5). 205-207.

STATUS OF WEAVERBIRDS IN AGRICULTURE AND THEIR MANAGEMENT

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Introduction :

In spite of the common and widespread occurrence of Weaver birds (*Ploceus* spp.) in India, assessment of status of Weaver birds is wanting in most parts of the country. In this paper, status and management of Weaver birds has been reviewed.

Status in relation to agriculture-Feeding habits :

Mathew (1976) described the feeding habits of Baya (*Ploceus philippinus*) with particular reference to Paddy cultivation in Cuddapah district of Andhra Pradesh. According to him, the birds feed on freshly sown seeds and/or standing crops of paddy (*Oryza sativa*) and millets from December to early April. The feeding habits of three weaverbird species viz., Baya (*Ploceus philippinus*), Black-throated weaverbird (*P. benghalensis*) and Streaked weaverbird (*P. manyar*) have been studied in Jullunder District, Punjab (Dhindsa, 1980). These three species have almost similar feeding habits in the field. During May-June, birds feed on rice seeds sown to raise nurseries and also on wheat (*Triticum aestivum*) and 'gulli danda' (*Phalaris minor*) grains from ground. Though 'bajra' is the main food item during June-October, weaverbirds also feed on 'swank' (*Echinochloa colonum* and *E. crusgalli*), an important weed in paddy. During October, birds feed on sorghum, bajra and paddy. In November, majority of the harvested paddy fields are ploughed for sowing wheat. From November to February, the weaverbirds survive almost exclusively on the grains left in the stored straw. Though the main food during February is paddy grains from the straw, the weaverbirds also feed on seeds of *Poa annua*, a grass found abundantly in fields of berseem (*Trifolium alexand-*

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rium), seeds of *Phalaris minor*, a very important weed of wheat.

Analysis of the diet of adults

In Cuddapah, the diet of adult *P. philippinus* consisted of 65 per cent (by dry weight) paddy, 12 per cent bajra and 12 per cent weed seeds of family *Panicaceae*. Animal parts make only about 3 per cent of the total diet (Mathew, 1976). In Jullunder (Punjab), about 98 per cent of the diet of *P. philippinus*, *P. benghalensis* and *P. manyar* was plant matter, the rest was animal matter (Dhindsa, 1980). Qualitative analyses of gut contents of *P. philippinus* adults have also been made in West Bengal and Orissa by Mukherjee and Saha (1974) and in Andhra Pradesh by Hamid Ali *et al.*, (1978). They also reported that the diet of adult weaverbirds consisted mainly of paddy. George (1974) observed adult *P. philippinus* feeding on small frogs (*Rana limnocharis*). Ali and Ripley (1974) mentioned that this species feeds on rice grains, hemp and other small seeds and insects.

Food preferences of adults in captivity

In captivity, *P. philippinus* and *P. manyar*, preferred *Echinochloa colonum* followed by *Phalaris minor* and paddy (both equally preferred) in the former species but *Phalaris minor* and bajra in the latter. The third species, *P. benghalensis*, however, preferred bajra and then *E. colonum*. Wheat was the least preferred food in all the three species. Therefore, it seems that the weaverbirds prefer weed seeds (*E. colonum* and *P. minor*) and bajra more than paddy. According to Mathew (1976), however, *P. philippinus* in Andhra Pradesh prefers paddy more than *Echinochloa* and korra (*Setaria* sp.). Hamid Ali *et al.*, (1978) also experimented with captive *P. philippinus* at Hyderabad (Andhra Pradesh) by keeping eight birds in one cage and offering them paddy, sorghum and bajra grains. They also found that paddy is preferred more than the other two items. More studies in this direction are needed.

Analysis of the diet of nestlings

Unlike adults, the diet of the nestlings of *P. philippinus*, *P. benghalensis* and *P. manyar* in Punjab mainly comprised of animal matter (57 to 77 per cent by wet weight). The plant matter made about 3 to 16 per cent (Dhindsa, 1980). In Andhra Pradesh also the insects formed major portions of the diet of *P. philippinus* nestlings (Mathew, 1976).

According to Mukherjee and Saha (1974) the nestlings of *P. philippinus* are fed on weed seeds, insects, snails and rice grains in Orissa and West Bengal. Ambedkar (1972) recorded *P. philippinus* feeding butterflies to its nestlings. In *P. megarhynchus* according to Ali and Ripley (1974) the nestlings are fed mostly on insects.

Conclusion

P. philippinus is considered to be an agricultural pest in Poona (Maharashtra) and farmers of that area destroy large number of their nests during peak breeding season (Ali and Ambedkar, 1956; Ambedkar, 1964). Mathew (1976) termed this bird to be a sporadic pest of paddy at Mannuthy, Kerala, on the basis of visual observation. However, there have been no studies on the assessment of useful and harmful activities of the weaverbirds in Maharashtra and Kerala on the basis of which a status to the birds could be assigned. In Punjab, the damage to wheat and paddy was negligible (less than 1%). The weaverbirds also consumed large quantities of grains of *Phalaris minor* and *Echinochloa* spp., which are important weeds of wheat and paddy, respectively. The weaverbirds are not the only depredators, because many other bird species also feed on agricultural crops. Moreover, in some regions agricultural crops (like bajra and sorghum) are cultivated only for fodder. The bird damage (about 48% in Jullunder) to their earheads is not an economic loss. Weaverbirds (especially *P. philippinus*) and House Sparrows, however, do a considerable damage (41%) to rice nurseries (Dhindsa, 1980).

The nestlings of weaverbirds are fed mainly on animal diet most of which is constituted by insects which were agricultural pests (Mathew, 1976; Dhindsa, 1980). The snails, are also destroyed by the weaverbirds by feeding them to their nestlings. The only useful animal in the nestling diet are spiders but these represent only about 20 per cent of the total diet in *P. benghalensis* and *P. manyar* and about 5 per cent in *P. philippinus* in Punjab (Dhindsa, 1980).

The nesting success of weaverbirds is poor due to many factors responsible for high mortality of eggs and nestlings. Their population is also low. Thus they can hardly be expected to inflict economic injury to agricultural crops nor to do commendable services by destroying insect pests and other harmful animals. Thus, their status is neutral (Mathew, 1976; Dhindsa, 1980). Whistler (1949) and Ali and Ripley

(1974) are also of the opinion that although weaverbirds feed on crops like paddy, sorghum, 'bajra' and other cereals, the damage is compensated via destruction of crop pests.

Management of Weaverbirds

The foregoing review suggests that in regions where ecology of weaverbirds has been studied, no control measures are required. However, in other regions where these birds are suspected to be harmful and in situations where they impose problems, the following suggestions may be helpful. (1) Avoiding very early sowing of crops. (2) Harvesting sugarcane in time and providing alternate food to the birds. In areas where weaverbirds attack paddy, the damage may be reduced by keeping small tracts of 'bajra' or *Echinochloa* as an alternate food for the birds. (3) Cultivating bird resistant varieties. The damage to bajra and sorghum, in areas where these crops are grown can be reduced by cultivating bird resistant varieties. In case of bajra the varieties with shed anthers and awns on the earheads are comparatively less prone to bird damage (Beri *et al.*, 1969). One of the most promising bajra varieties in Punjab is PHB-44. In sorghum Br-60 and Bird-Go are somewhat resistant to bird attack (Mehrotra and Bhatnagar, 1979) as these are higher in tannin contents. (4) The damage to rice nurseries can be minimized by sowing the seeds treated with 0.5% methiocarb (4-methylthio-3, 5-Xylyl N-methylcarbamate), a bird repellent (Dhindsa and Toor, 1980). (5) Destroying weaverbird colonies during breeding season.

If weaverbirds pose pestilence problems, their population can be checked by destroying their nests in the breeding colonies preferably when nestlings have attained age of 9-10 days.

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REFERENCES

Ali, S. and Ambedkar, V. C. (1956). Notes on the Baya weaver bird, *Ploceus philippinus* Linn. *J. Bombay nat. Hist. Soc.*, 53: 381-389.

Ali, S. and Ripley, S. D. (1974). *Handbook of the Birds of India and Pakistan*. Vol. 10. Oxford Univ. Press. Bombay, London, New York.

Ambedkar, V. C. (1964). *Some Indian Weaverbirds: a contribution to their breeding biology*. Univ. of Bombay.

Ambedkar, V. C. (1972). The Baya *Ploceus philippinus* (Linn.) feeding nestlings with butterflies. *J. Bombay nat. Hist. Soc.* 69:653-654.

Beri, Y. P., Jotwani, M. G., Misra, S. S. and Chander, D. (1969). Studies on relative bird damage to different experimental hybrids of bajra. *Indian J. Ent.*, 31: 69-71.

Dhindsa, M. S. (1980). Ecological studies on the weaverbirds of the Punjab and their control. Unpubl. Ph.D. thesis. Punjab Agricultural University, Ludhiana.

Dhindsa, M.S. and Toor, H.S. (1980). Extent of bird damage to rice nurseries in the Punjab and its control. *Indian J. agric. Sci.*, 50: 715-719.

George, N.J. (1974). Baya (*Ploceus philippinus*) feeding on frogs. *J. Bombay nat. Hist. Soc.*, 70: 381.

Hamid Ali, M.; Manmohan Singh, T.G.; Banu, A; Anand Rao, M. and Sainath Janak, A.T. (1978). Observations on the food and feeding habits of Baya Weaver, *Ploceus philippinus*. *J. Bombay nat. Hist. Soc.*, Supplement 75:1198-1204.

Mathew, D.N. (1976). Ecology of the weaver birds. *J. Bombay nat. Hist. Soc.*, 73:249-60.

Mehrotra, K.N. and Bhatnagar, R.K., (1979). Status of Economic Ornithology in India-Bird Depredents, Depredations and their Management. Indian Council of Agricultural Research, New Delhi.

Mukherjee, A.K. and Saha, B.C. (1974). Study on the stomach contents of common Baya, *Ploceus philippinus* (Linnaeus). *J. Bombay nat. Hist. Soc.*, 71:308.

Whistler, H. (1949). *Popular Handbook of Indian Birds*. Oliver & Boyd; Edinburgh and London.

EFFICACY OF SOME RECENTLY DEVELOPED PESTICIDES AGAINST AVIAN DEPREDATORS AND SHOOTFLY INFESTATION UP TO SEEDLING STAGE IN SORGHUM CROP

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Introduction :

Seed loss at sowing by predatory aves is considerable and the only commonly employed method of control is continuous scaring. The seed covered up with raked over soil is also picked out by common ground feeding aves notably the Columbids, like *Columba livia* (Gmelin), *Streptopelia decaocto* (Frivald.). Often common Corvids, also depredate germinated seeds and the soft sprouts. Besides seed loss at initial stage by predatory aves, the seedlings losses are heavy by shootfly *Atherigona soccata* (Rondani) to the extent of total loss (Usman, 1968 and Sukhani and Jotwani, 1979).

For control of shootfly considerable management technology is available (Jotwani and Young, 1972). However, problem of depredatory aves has so far received meagre attention (Bhatnagar, 1976; Mehrotra and Bhatnagar, 1979 and Bhatnagar, 1980). The problem is complex as in many sorghum growing areas, the avian depredatory species may comprise several protected or endangered species (Bhatnagar, 1980). Even in northern India, the most common protected species affecting depredations at sowing, in many crops is national bird the peacock, *Pavo cristatus* (Linn.). The depredatory activities of the species have been reported by several workers in different crops (Butani, 1971; Bhatnagar, 1976b and Mehrotra and Bhatnagar, 1979). For control of depredation by such and other depredatory species approaches affecting feeding aversions offer promise (Bhatnagar, 1980).

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Materials and Methods

Replicated field trial conforming the recommended agronomical practices was taken up at the farm area of Indian Agricultural Research Institute, New Delhi during Kharif, 1981. Counted seeds of variety CSH-5 were sown by hand dibbling at 15 cm. distance. A plot consisted of 4 rows, each measuring 3 m in length and 240 seeds were sown per plot. The tests on germination viability was taken up in simulated laboratory conditions. The data is given in self explanatory tables after deduction of the germination viability index which was 2% in all the seed treatments. For seed treatment, three concentrations of each chemical namely landrin, methiocarb and carboxin were used. The former two are known avian feeding repellents (Schaffer *et al.*, 1967), the latter compound was chosen as in laboratory test. It had been observed that aves show aversions to seeds treated with fungicides too.

The field data were recorded from sowing to leaf-stage of sorghum seedlings. The data on averages are given in Table-1. Seed loss due to birds was taken from 'pecking' or 'scratching' marks on sown seed furrows. observations on Shootfly were recorded on 12th and 24th day after germination.

Results

The data in Table 1 show that the seed loss ranged from 47 to 145 seeds per plot. The percentage of seed loss ranged from 19.17 to 59.73. Maximum seed losses are 59.73% and 58.61%, respectively with 0.34% Carboxin seed treatment and untreated seed coated with gum acacia alone. 5% level differences were statistically significant. Losses in Corboxin seed dressing were statistically at par with untreated. Seed depredation in dressings with methiocarb and landrin treatments are statistically at par. No mortality in depredatory aves was noticed in the field where these experiments were conducted.

Data in Table 2 show that average plant stand per treatment ranged from 78 to 188. Significantly higher plant stand is observed in methiocarb and landrin seed treatments. Highest i.e. 188 are in seed treatment with 0.3% landrin and 166 with 1.0% methiocarb. Seed treatment with Carboxin and untreated showed lowest plant stand ranging from 78 to 100 and both are statistically at par. The percentage side tillers ranged 13.71 to 60.00 and higher per cent tillers are observed in 0.34% landrin, 0.19% carboxin and untreated check.

Shootfly infestation till 12th day ranged 0.82 to 3.85 per cent on plant population. During this period maximum infestation (5.08%) was recorded in 0.34% landrin seed treatment. In the same way 0.82, 0.71 and 0.63 per cent infestation were respectively observed in seed treatment 0.15% landrin, 0.25% methiocarb and 1.0% methiocarb. Shootfly infestation till 24th day after germination ranged 16.39 to 33.89 per cent. Statistically significant reduction in shootfly infestation was observed in treatments with 1.0% landrin (21.51), 0.15% landrin (16.47) and 1.0% methiocarb (17.91) as compared to all other treatments including check.

Overall results show significant reduction in shootfly infestation in seed dressing with 0.15% landrin and 1.0% methiocarb seed dressing with Carboxin 0.34% and landrin (0.34%) proved to be ineffective.

Discussion

The data indicated that seed treatments with landrin and methiocarb offer considerable protection against seed and seedling losses due to birds. The unprotected plots showed 58.61 per cent seed losses. Carboxin seed dressings at recommended concentrations (for fungi infestation control) do not show promise in controlling seed loss by birds in field trials. Effect of carboxin in caged birds, therefore may be due to captivity behaviour or the decomposition of compound in soil at faster rate than in pans.

Seed dressings with 0.15% landrin showed lowest per cent infestation in plants and which is lower than that in 1.0% landrin. This may be due to locational effect. However, the treatments can be expected to offer equal protection against shootfly infestation and it is comparable to methiocarb seed treatment. Amongst these, methiocarb seed treatments in 1.0% concentration appears effective.

These preliminary studies amply indicate that studies on bird damage control should also take into account effects on other pests. These however, have hitherto been unreported.

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Table 1 : Seed loss in CSH-5 Sorghum at seeding stage

Seed treatment	Av. seed-lings present in each plot	Av. no. seed loss per plot	Av. % seed loss plot due to birds	Remarks
T ₁ 0.10% landrin	*189.00	51.00	19.16	*SEM±
T ₂ 0.15% landrin	171.00	69.00	26.66	15.3185
T ₃ 0.30% landrin	178.33	61.67	23.69	SED 21.663
T ₄ 0.19% Carboxin	129.33	110.67	45.28	CD at
T ₅ 0.26% Carboxin	112.00	128.00	52.50	0.05% =
T ₆ 0.34% Carboxin	94.66	145.34	59.73	46.515
T ₇ 0.25% methiocarb	184.33	55.66	22.40	CD at
T ₈ 0.50% methiocarb	186.33	53.67	21.53	0.01% =
T ₉ 1.00% methiocarb	193.00	47.00	18.75	34.812.
T ₁₀ Untreated seed (coated with 0.5% Gum acacia).	97.33	142.67	58.61	

Table 2 : Efficacy of seed treatments for bird control and against shoot fly infestation in Sorghum (Treatments are as in Table 1).

Seed treatment	Av. Plant stand per plot	Av. % Tillers per plot	Av. % Infested with shoot-fly till 12th day.	Av. % Plant Infested with shoot-fly till 24th day.	Overall % Plants infested with shoot-fly
1	2	3	4	5	6
T ₁ 0.10% landrin	127	33.59	1.57	19.94	21.51
T ₂ 0.15% landrin	122	29.78	0.82	16.39	16.47
T ₃ 0.30% landrin	188	57.90	5.08	33.89	38.97
T ₄ 0.19% Carboxin	100	60.00	2.00	29.33	31.33
T ₅ 0.26% Carboxin	78	51.28	3.85	31.61	35.46
T ₆ 0.34% Carboxin	81	33.74	2.47	28.39	30.86

1	2	3	4	5	6
T ₇ 0.25% methiocarb	141	13.71	0.71	24.34	4.41
T ₈ 0.50% methiocarb	137	47.93	1.46	26.27	27.73
T ₉ 1.00% methiocarb	160	33.37	0.63	17.28	17.91
T ₁₀ Untreated seed (coated 83 with 0.5% Gum acacia).	39.76	1.20	29.31	30.52	
SEM ±10.61736			12.789		
SED 15.0152			18.08678		
CD t 0.05% 31.5469			37.6205		

REFERENCES

- Bhatnagar, R.K. 1976a. Significance of bird management and control. *Pesticides Annual*, 6:47-83.
- Bhatnagar, R.K. 1976b. Bird pests of Agriculture and their control. *Proc. Nat. Acad. Sci. India*. 46(B) I & II:245-256.
- Bhatnagar, R.K. 1980. Studies on Avian Depredation and its control in certain agricultural crops. Ph. D. thesis, Meerut Univ., Meerut.
- Butani, D.K. 1971. A non insect pest of cotton. *Entomol. Newslett.*, New Delhi 1(7):53.
- Jotwani, M.G. and W.R. Young. (1972). Recent development on chemical control of insect pests of sorghum pp. 377-398 *In Sorghum in Seventies*, (N.G.P. Rao and L.R. House eds.) Oxford and IBH Publishing Co., New Delhi.
- Mehrotra, K.N. and Bhatnagar, R.K. 1979. Status of economic Ornithology in India : Bird depredents, depredation and their management., ICAR, New Delhi, 79 pp.
- Schafer, E.W. Jr., Starr, R.L., Cunningham, D.J. and Decino, T.J. 1967. Substituted phenyl N. methylcarbamates as temporary immobilising agents for birds. *J. agric. Food. Chem.*, 15(2) : 287-289.
- Sukhani, T.R., and Jotwani, M.G. 1979. Effect of site of oviposition on shootfly damage to different growth stages of Sorghum seedlings. *Indian J. Ent.*, 41(4) : 366-370.
- Usman, S. 1968. Preliminary studies on the incidence of shootfly on hybrid jowar under differential sowings. *Mysore J. agric. Sci.*, 2(1) : 44-8.

THE COMMON BAYA : A PROBLEM BIRD OF CULTIVATORS IN WEST BENGAL

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Introduction

Various aspects of the behaviour and ecology of the Common Baya, *Ploceus philippinus* (Linnaeus) have been studied by Jerdon (1863), Dewar (1909), Ali (1931), Ali and Ambedkar (1956, 57), Ambedkar (1964), Ali and Ripley (1974), Crook (1961), Mathew (1972, 1976) and Mukherjee and Saha (1975). Evaluation of its economic status was first taken up by Mason and Lefroy (1912) who reported that the bird should be looked as harmful to the crops. The role of the bird in agricultural economy has not been properly determined. The present study was undertaken to determine the economic status of the concerned species in parts of West Bengal.

Material and Methods

A study was undertaken in southern districts of West Bengal viz., 24-Parganas, Nadia and Bankura. From these, typical areas were selected for field survey in Basirhat, Habra (24-Parganas district), Chakdah (Nadia district) and Pratappur (Bankura district), where three paddy crops a year covering spring, summer and monsoon (March-Sept.), and Autumn and Winter (October-January) are grown. During March-April and June-July, sowing of 'Aus' and 'Anan' takes place and harvesting in August-September and November-January, respectively. In these districts paddy varieties-Taichung, Jaya, Ratna, IR 8 and Pankaj are grown. These mature in three months. The bird thereby has a prolonged period (9 months) of activity in the cultivated tracts.

During surveys (1972-76), some 574 samples of adults, sub-adults and nestlings were collected, from the above mentioned areas for their stomach-contents analyses (thrice a year). Samples were obtained in

Zoological survey of India, Calcutta.

summer between 6.00 to 9.00 hr and late afternoon between 16.00 to 18.00 hr. During winter, samples were collected one hour later in the morning and one hour earlier in the evening. Adults and sub-adults were collected by mist nets, shooting at perch or while busy feeding on ground. Nestling birds were collected from brooding chamber of nests. Live birds were killed by chloroform or benzene in air-tight polythene bags. Birds were dissected open for estimating gut-contents by gravimetric method (Mukherjee, 1969). This comprised crushing of contents in water, semi drying on blotting paper, exposing in air for about half an hour, weighing, finally fixing in 90 per cent alcohol and transferring to 70 per cent alcohol after 24 hours for laboratory analysis. The contents were separated out into inorganic and organic groups, the latter was further separated into vegetative and animal matters. Each item of food was weighed after drying in air for about 50 minutes. For determination of items, samples were compared with the items in field from where the birds were captured. Identification of the gut contents was confirmed by specialists from the Zoological and Botanical Surveys of India.

The detailed analyses of food of adults in breeding and non-breeding seasons are given in Table 1. The food of nestlings and fledglings have been indicated in Table 2.

Discussion

Owing to extensive cultivation of paddy and its availability almost throughout the year in West Bengal, the bird was found feeding on paddy either from standing crop, stubbles, or from thrashing floors, hay-stacks and while drying in the sun before dehusking. Birds thus cause considerable damage to the crop.

Common Baya made 15-20 trips on an average from their roost on sugarcane, bamboo thickets etc., to the nursery and cultivated fields of paddy. Each bird consumed about 7.5 grams of paddy in a day. At this rate, a flock of over 200 birds foraging in one square kilometer will consume nearly 15 kilogram per day. The loss appears to be quite heavy.

From the foregoing analysis it may be inferred that during the first 5 to 6 weeks of their life (nestling and fledgling stages), the nestlings are fed on insects, some of which are pests, but these young ones are also given cereal food which are mostly paddy grains (Mukherjee and Saha, 1975). The adults are mainly dependent on cereal crop.

Table 1: Crop and stomach-contents of adults during the non-breeding period

		Sample Nos. 155				
		October	November	December	January	
		(Percentage)				
Organic	Vegetative matter	80.40	92.95	93.38	98.61	
	Paddy+husk	11.78	6.38	0.94	—	
	Grass seeds	2.24	0.75	0.11	0.05	
	Arthropoda (Insecta)	0.12	—	0.54	0.12	
Inorganic	Mollusca	5.42	—	5.03	1.22	
	Grit	—	—	—	—	

Crop and stomach-contents of adults during breeding season

		Sample Nos. 126				
		May	June	July	August	September
		(Percentage)				
Organic	Vegetative Matter	98.13	97.78	67.04	65.53	60.35
	Paddy	—	—	30.24	26.63	14.00
	(Grass seeds)	0.58	1.44	1.69	5.46	5.94
	Insecta	—	—	0.19	—	—
Inorganic	Arachnida	—	—	—	—	—
	Mollusca	—	0.18	0.10	0.61	8.94
	Grit	1.23	0.60	0.74	1.76	10.75

Stomach-contents of nestlings and fledglings during breeding seasons									
Sample Nos. 293									
Organic	Vegetative Matter	Paddy	27.42	20.41	2.58	18.29	14.98		
		Grass seeds	—	—	—	—	9.44		
	Animal Matter	Insecta	65.01	66.96	95.09	66.80	62.80		
		Arachnida	—	2.59	—	9.21	4.03		
Inorganic		Mollusca	7.08	9.40	2.33	4.12	5.46		
		Grit	0.36	0.06	—	1.53	3.26		
Analysis of insect-food of nestlings									
Class Insecta	Order	Orthoptera	15.00	4.37	94.61	56.26	45.32		
"		Dictioptera	—	—	—	0.04	—		
"		Coleoptera	50.01	42.66	—	3.02	3.35		
"		Odonata	—	—	—	—	traces		
"		Neuroptera	20.56	—	—	—	1.57		
"		Lepidoptera	1.25	5.37	0.48	6.73	—		
"		Diptera	—	—	—	—	0.08		
"		Psocoptera	0.48	—	—	—	—		

If has been found that due to extensive paddy cultivation and its availability almost throughout the year, the bird takes paddy as its staple diet. Though during the juvenile stages this bird consumes insects, some of which are serious pests on crops, yet it caused considerable damage to paddy in the study area. There is very little to say in favour of the Common Baya in the study area.

Table 2: List of Identified Material of Animal Matter as found in Nestling

PHYLUM ARTHROPODA		
Identified species etc. (i)	Status (ii)	Chief host plant (iii)
Class Insecta : Order Orthoptera : Family Acridiidae		
<i>Aiolophus tamulus</i> Fabr.	Pest	Cotton and paddy nurseries
<i>Aiolophus</i> spp.,	Pest	Paddy nurseries
<i>Oxya hyla hyla</i> Serville	Pest	Cabbage, Paddy, Para
<i>Oxya fuscovittata</i> (Marschall)	Pest	Paddy, Maize
<i>Oxya</i> spp.	Pest	Paddy, Hybrid Napier
<i>Gesonia punctifrons</i> (Stal)	Pest	Colocasia, Water Hyacinth
<i>Hieroglyphus baniyan</i> (Fabr)	Pest	Paddy, Jowar.
<i>Acrida exalta</i> (Walker)	Pest	Paddy, Para, Grass Hybrid Napier etc.
<i>Acrida</i> spp.	Pest	-do-
<i>Eyprepocnamis</i> sp.	Pest	Paddy, <i>Padyanthus tithymaloides</i>
Family Tettigoniidae		
<i>Euconocephalus</i> sp.	Pest	<i>Antigonon</i> sp., grass (wild)
<i>Xiphidiopsis</i> sp.	Pest	Para, Paddy
<i>Hexacentrus</i> sp.	Pest	<i>Antigonon</i> sp., (grass wild)
Family Pyrgomorphidae		
<i>Atractomorpha crenulata</i> (Fabricus)	Pest	Tobacco, Paddy, Millet, Para.
<i>Atractomorpha</i> sp.	Pest	Young Maize, Tobacco.
Order Dictioptera		
Family Mantidae	(non-pest)	Predator

i	ii	iii
Order Coleoptera		
Family Cerambycidae	Pest	Wood borer
Family Curculionidae		
<i>Mylocerus</i> spp.	Pest	Ladies-finger (Bhindi), Brinjal.
<i>Apion</i> sp.	Pest	Ground nut, Green gram, Jute.
Family Scarabaeidae		
Family Carabidae	Non Pest	Predatory ground beetle
Family Tenebrionidae		
<i>Tribolium castaneum</i>	Non Pest	Predatory (feeds on dead dried leaves)
Family Staphylinidae	Non Pest	
Order Odonta—Wings of Zygo- ptera		Beneficial
Order Neuroptera Family		Carnivorous
Ascalaphidae		(Predatory Insects)
Order Lepidoptera Family		Larvae and pupae
Sphingidae		Leguminosae
<i>Acherontia styx</i> Westw.		Food plants-Solanaceae Verbenaceae, Mystaceae.
Order Diptera Family Phoridae	Non Pest	Cucurbitaceae, Oleaceae
Order Psocoptera-Nymphs	Non Pest	Bignoniaceae, Pedalineae, Laliotae
Class Arachnida Family		
Clubionidae	Non Pest	Carnivorous
<i>Clubiona</i> spp.	Non Pest	Mainly help in Pest Con- trol
<i>Chiracanthium</i> sp.	Non Pest	
Cocoons of Clubionidae		
Family Oxyopidae		
<i>Oxyopes hindustanicus</i>	Non Pest	
Pocock		
<i>Oxyopes</i> spp.	Non Pest	
Family Agriopidae (Araneidae)		
<i>Araneus</i> sp.	Non Pest	
<i>Chorizopes</i> sp.	Non Pest	

i	ii	iii
Family Lycosidae		
<i>Lycosa sumatrana</i>		
Thorell	Non Pest	
<i>Lycosa carmichaeli</i>		
Gravely	Non Pest	
Family Salticidae		
<i>Phidippus</i> sp.	Non Pest	
<i>Myrmarachne</i> sp.	Non Pest	
<i>Plexippus</i> sp.	Non Pest	
Family Theridiidae		
<i>Theridion</i> sp.	Non Pest	
Family Linyphidae		
<i>Linyphia</i> sp.	Non Pest	

PHYLUM MOLLUSCA

Class Gastropoda Family	Non Pest	Nil
Pilidae		
<i>Pila</i> sp.		Nursery plants, paddy.
Family Melaniidae		
<i>Melanoides tubercula- tus</i> (Muller)	Non Pest	
<i>Melanoipes</i> spp.	Non Pest	
Family Palanorbidae		
<i>Gyraulus convexiusculus</i>	Non Pest	
Hutton		
<i>Gyrulus</i> spp.	Non Pest	
Family Amnicolidae	Non Pest	

REFERENCES

- Ali, S. 1931. The nesting habits of Baya (*Ploceus philippinus*). *J. Bombay nat. Hist. Soc.*, 61 : 60-68.
- Ali, S. and Ambedkar, V.C. 1956. Notes on the Baya Weaver bird *Ploceus philippinus*. *J. Bombay nat. Hist. Soc.*, 53 : 381-389.

- Ali, S. and Ambedkar, V.C. 1957. Further notes on the Baya Weaver bird (*Ploceus philippinus*). *J. Bombay nat. Hist. Soc.*, **54** : 491-502.
- Ali, S. and Ripley, S.D. 1974. *Handbook of the birds of India and Pakistan*. 10. Oxford Univ. Press, Bombay.
- Ambedkar, B.C. 1964. Some Indian Weaver birds. A contribution to their breeding biology, Bombay University.
- Crook, J.H. 1960. Studies on the reproductive behaviour of the Baya Weaver *Ploceus philippinus* (L.). *J. Bombay nat. Hist. Soc.*, **57** : 1-44.
- Dewar, D. 1909. The nesting habit of the Baya. *J. Bombay nat. Hist. Soc.*, **19**, 627-634.
- Jerdon, T.C. 1863. *Birds of India*, 2. George Wyman, Calcutta.
- Mason, C.W. and Maxwell-Lefroy, H. 1912. The food of birds in India. *Mem. Dept. Agric. India (Ent. Ser.)*, **3** : 122-23.
- Mathew, D.N. 1972. The ecology of the Baya in Rajampet, Cuddapah District, A.P. *J. Bombay nat. Hist. Soc.*, **69** : 188-191.
- Mathew, D.N. 1976. Ecology of the Weaver Bird. *J. Bombay nat. Hist. Soc.*, **73** : 250-260.
- Mukherjee, A.K. 1969. Food-habits of water birds of the Sunderban, 24-Parganas district, West Bengal, India. *J. Bombay nat. Hist. Soc.*, **66** : 346-360.
- Mukherjee, A.K. and Saha, B.C. 1975. Study on the stomach contents of Common Baya, *Ploceus philippinus*. *J. Bombay nat. Hist. Soc.*, **71** : 308.

CARBOFURAN SEED TREATMENT TO CHECK DAMAGE BY BLUE ROCK PIGEON, *COLUMBA LIVIA* AT SOWING IN SORGHUM CROP IN SELECTED AREAS

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ABSTRACT

Experiments conducted at the Institute farm during 1968 to '82, primarily for shootfly control, have also confirmed high avicidal property of 2-5 per cent Carbofuran seed treatment against a common, depredatory, seed picking bird, *Columba livia* (Gmelin) at sowing.

It was observed that when 1-2 pigeons were killed after feeding on the treated seeds in the experimental plots, others were scared and left the area. After mortality in a few pigeons, the behavioural posture affected partial to complete scaring in other pigeons and thus affected dispersal of others as well checked further settling. Utilization of such behavioural postures with decoy models has been tried in England. Cost wise the method with toxicant proves effective for Indian conditions. However, in areas protected species are involved. alternate chemicals like feeding repellents are expected to be useful with manipulation in abundance of species in term of feeding on seeds by manual scaring. The toxicant treatment can be used in area where protected species are involved. This reduces the chances of mortality in such species. To check mortality in predatory birds, the dead pigeons should be buried after germination.

For integrated approach the treatment with carbofuran showed promising usages to reducing depredations by notified depredatory species with limited permissible mortality.

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COMMON HOUSE SPARROW AND WEED CONTROL

M.B. SHARMA AND O.P. SINGH

ABSTRACT

Under controlled conditions, the Common house sparrow (*Passer domesticus indicus* J & S) has been recorded feeding on many obnoxious weeds, viz., *Phalaris minor* Retz (Bandra Bandri), *Vicia sativa* Linn. (Gagla), *Rumex* sp. Linn. (Jangli Palak), *Amaranthus visidis* Linn. (Jangli matar) and *Phyllanthus niruri* Linn. (Hazar dana, Jaramla, jangli amli) of major Rabi and Kharif crops of district Meerut in addition to 4 common weeds *Chenopodium murale* Linn. (Kar Bathua), *Mollis indica* All (Sweet clover, murale), *Aspodelus tenuifolios* Cav. (Slender-leaved asphodelus, piazzi) and *Buphorbia dracunculoides* Lamk (jychre oil, dudhi) reported earlier. On an average, an adult house sparrow consumed 4.627 gm seeds of *Phalaris minor* or *Vicia sativa* 2.837 gm or *Rumex* sp. 1.060 gm or *Amaranthus viridis* 1.058 gm or *Lathyrus aphaca* 0.641 mg or *Phyllanthus niruri* 4.08 gm in a day. In field also, the house sparrow was observed feeding on these weed seeds.

BIRDS AS INSECT SUPPRESSING AGENTS

ABRAHAM VERGHESE,* A.K. CHAKRAVARTHY** AND
S. SUBRAMANYA***

ABSTRACT

Birds draw parallel to insects of the invertebrate world in that both have the ability to fly. Their habitats are related and in many birds insects constitute an important part of the food intake. Viewing economically birds limit the build-up of insect population, which in many cases, go unnoticed. From Indian angle, investigations on the role of insectivorous birds have so far, been meagre. This paper, therefore, highlights the importance of birds as a limiting factor to insect build-up. The salient features are highlighted here.

In our field surveys and studies in Bangalore between 1972 and 1977, we have come across several instances of effective bird predators, which will be elaborated in the main paper. Some of them are as follows:

Predator	Pests
1. <i>Prinia socialis</i>	<i>Aphis gossypii</i> , <i>A. fabae</i> , <i>A. craccivora</i>
2. <i>Corvus splendens</i>	<i>Odonotermes</i> sp.,
3. <i>C. macrorhynchus</i>	<i>Holotrichia</i> sp., <i>Spodoptera litura</i> .
4. <i>Merops orientalis</i>	<i>Pieris</i> sp., <i>Odonotermes obesus</i>
5. <i>Motacilla flava</i> , <i>M. caspica</i>	<i>Aphis craccivora</i>
6. <i>Oriolus oriolus</i>	<i>Diacrisia obliqua</i> , <i>Adisura atkinsoni</i> , <i>Heliothis armigera</i>
7. <i>Upupa epops</i>	<i>Diacrisia obliqua</i>

Emitic analysis on the fledglings of *Prinia subflava* conducted at UAS, revealed that over 80% of the fledgling food was insect pests. *Trichoplusia signata*, a semilooper on ragi alone constituted 64.10% of the food. Suggestions to augment insectivorous birds in natural ecosystems are also given in the paper.

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STUDIES ON BIRDS DAMAGING CEREALS WITH SPECIAL REFERENCE TO PEARL MILLET

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ABSTRACT

Birds are serious constraints to cereals production. The granivores cause severe grain losses particularly in the arid and semi-arid tracts of India and Africa, where millets are staple food (Verma, 1980). Instances of total bird depredations in Rice from Nigeria (Funmilayo and Akinwade, 1979), and in Sorghum from Botswana (Beesley and Lay, 1979) are common. The damage *Quelea quelea* does to cereals in Africa exceeds 200 million dollars annually (Shireman, 1978).

The present study was carried out for three years 1975-1977 at the University of Agricultural Sciences, Bangalore. Detailed foraging studies on a variety of grain crops were carried out. Some of the highlights of the study are given below.

Small grain crops suffering maximum damage mainly by Estrilids (*Lonchura* sp. mainly) and Ploceids are in the following order: Pearl millet, Sorghum, Navane (*Setaria italica*) and Finger millet (*Eleusine coracana*). In a screening study on pearl millet, No. F 612 A, a bristled variety, was less preferred. Burton and Powell (1970) are of the opinion that if long bristles afford protection without reducing harvestable grains, then they must be added to future varieties. Our studies also showed that taller varieties, on account of more accessibility, were more susceptible. Thus planting a tall variety in small strips near cultivated bajra, may reduce depredation due to birds, as it was evident in our studies. The length of time grains are exposed to birds also matter. Thus late maturing varieties received more damage score than early maturing ones. It could also be inferred that the least pre-

ferred species can be grown in small strips to divert the attention of the bird from the main field.

Besides these cultural recommendations, exclusive study on the most populous and degrading bird is warranted. Depending on the bird species, the order of preference, mentioned earlier may vary. Thus white-throated munia prefers 'navane' to pearl millet. Where this munia is a menace, planting 'navane' in strips in the main crop area is recommended. Crows and parakeets, also visit millet agro-ecosystems though the former is an omnivore and the latter is essentially frugivore bird.

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STUDIES ON APPRAISAL OF BIRD DAMAGE IN PEARL MILLET, *Pennisetum typhoides* STAPH. & HUBBARD AND ITS CONTROL

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PREM KISHORE AND M. RAIZADA

Introduction :

Pearl millet or 'bajra' is now widely cultivated as grain and fodder crop in Himachal Pradesh, Jammu and Kashmir, Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana and its cultivation amounts to 11.0 per cent of the total cereal production in India.

The crop is highly susceptible to bird damage although its cultivation belt. Jotwani *et al.*, (1969) have reported that due to excessive bird damage at grain formation stage farmers in many areas prefer to cultivate the crop for fodder purpose only. Owing to serious damage by birds, plant breeders and agronomists have suggested cultivation of sown varieties (Singh, 1980 and Bhatnagar *et al.*, 1974). Beri *et al.*, (1968) reported varietal susceptibility in bajra to bird damage. Many workers (Bhatnagar 1976a and b; Jain and Prakash, 1974; Fitzwater and Prakash, 1979 and Mehrotra and Bhatnagar, 1979) also reported serious depredations by birds in the crop. From the review of the work done on bird damage it appears that statement of Pardee (1979) that bird damage is (often) equal to combined losses due to insects and rodents seems to hold good, the most in this crop.

The complex of predatory species or the avian pest complex on the crop is varied. Bhatnagar (1980) has reported that at sowing stage, although only 2.81% of the total avian species affect, yet, problem is complex as 95% of these species are either protected or have dual economic status. Further out of these, only 0.74% show preference to sown seed (sprouting) but even, of these more than 50% are

protected species. According to Bhatnagar (1980) similar is the status of 29 predatory species at grain formation stage barring the psittacid species. The later species too can not be subjected to population reduction as the legal legislation and studies on its probable ecological impact in the biosphere are still wanting. These aspects deserve visualisations in wider perspectives, especially in terms of distribution of these predatory species which are met in all the agroclimatic regions of India. Therefore, the problem is varied and complex all over the country. Bhatnagar (1980) has further observed that zoogeographically the percentage of predatory species appears meagre but when taken in terms of numerical values, especially in context to population of individual species, their food intake rate *i.e.*, consequent extent of depredation and their varied economic status, the problem of management of predatory species to reduce crop losses has a vast magnitude to describe here.

Fore gone considerations on the complexities in the management of predatory species of crop necessitate studies with feeding repellent and deterrents only, so that crop losses are reduced with least effects to causative species. In this context mention be made that methiocarb 4 (Methylthio)-3, 5-Xylyl methylcarbamate is considered by many as wide spectrum avian feeding repellent (West and Junks, 1969; West *et al.*, 1969 Guarino and Forbes, 1970; Crase and Dehaven, 1976 and Mehrotra and Bhatnagar, 1979). In action, the repellency is affected by causing pre-ingestional disturbances (Schaffer *et al.*, 1967) and leads to the development of feeding aversions which are expected to develop as 'learned aversions' according to Roger's hypothesis (Rogers, 1974). In action, Malathion (0, 0-Dimethyl phosphorodithioate of diethyl mercaptosuccinate) as feeding deterrent reported by Mehrotra *et al.*, (1967) is also expected to be similar in terms of avian behaviour. Therefore, feeding repellents and deterrents hold promise as compounds least damaging to avian species in wider perspectives.

Materials and Methods:

The experiment was conducted in the farm area of the Indian Agricultural Research Institute during *Kharif* 1979 and 1980 seasons. The trial was laid out in randomised block design with four treatments, each replicated four times on recommended agronomical practices (Singh, 1983) on certified seeds of variety BMH-24. Data is given in the tables which are self explanatory. Repellency, deterrence,

germination and phytotoxicity were evaluated in laboratory cages, prior to field experimentation and optimal dosages were utilised.

Bird damage at sowing stage:

Bird damage at sowing stage commences immediately after sowing if there is no disturbance to birds like scaring and presence of 'human interference'. Periodicity of visitant depredatory species is more in morning and late afternoons. However, if there is no disturbance or there was disturbance in previous feeding time, the feeding is there even during noon. The seed depredation continues till complete seedling is formed. At sowing stage, the species affecting losses are the common columbids like *Columba livia* Gmelin and *Streptopelia decaocto* Frivald. The common crow, *Corvus splendens* Vieillot rarely damage sown seeds, but sometimes does pull out sprouting grains.

In Delhi region, the seed loss ranges from estimated 1.24 kg/ha to 1.79 kg/ha. This on computation comes to 9.55 per cent of the recommended seed rate of 13 kg/ha. However, in broadcast sowing the seed loss is obviously expected to increase as exposed seeds are picked more than seeds sown in furrows and wherein even *Passer domesticus* (Linn.), the common sparrows start depredating seeds. The seed loss affects gaps in the sown seed lines which eventually promotes further depredations at grain maturity. The study undertaken at decreased availability by sowing @ 2.108 kg/ha than 13 kg/ha revealed interesting points, revealed that gaps due to losses of sown seeds range quite low from 1.066 sq.mt. to 17.00 sq. mt./ha. However, if the plant to plant gap i.e., at over all seed rate of 13 kg/ha is followed, eventual losses would be obviously much higher than the appraised estimates. The average food intake rate is 30 gm/24 hr per individual of columbid (especially the *Columba livia* Gmelin) and average flock density of 75 individuals over their preferred food item, the 'bajra' seed picked is relied upon as an index of extent of losses, it becomes apparent that 2.25 kg/day. However, in nature many extragenous and unknown factors affect the feeding and feeding rate varies. This invokes two interesting points in context to avian depredations whether the recommended seed (sowing) rate of 13 kg/ha takes into account the losses due to birds and whether it is not too high if the losses due to birds are controlled for then it would mean wasteful inputs at high seed rate. However, the study quite conclusively reveals the need of controlling avian depredations at sowing stage.

Table 1 : Bird damage at sowing stage in 'Bajra' variety BMH-24. The rate refers at 100 seed weight of 527 mg. or average seed weight of 5.27 mg and @ 30 seed/mt of 158.1 mg/metre row

Plots	No. seeds lost/mt.	Weight of seed loss in gm/mt	Gaps per mt. row due to seed picking	Seed loss kg/ha	Gaps in sq. mt/ha
1	22.67	0.1195	1.1133	1.5993	15.1066
2	17.50	0.0922	0.0875	1.2293	11.6666
3	25.50	0.1344	0.1275	7.7920	17.0000
4	17.67	0.0931	0.0908	1.2413	14.6666

Control of bird damage at sowing stage

The data in Table-2 reveals that even in treated seeds the depredations due to birds ranges from 1.19 kg/ha to 1.33 kg/ha against 1.54 kg/ha under untreated conditions. Statistical differences were non significant. But seed dressings gave marginal increase. Seed treatments with methiocarb with solvents appeared to affect germination. Treatments appeared to hold promise as it did not cause any mortality in birds.

At milky stage, bird damage is mainly by Fringillids, namely the Munias, *Lonchura punctulata* (Linn). These triturate the soft grain. Occasionally, Ploceids, viz., House sparrows *Passer domesticus* (Linn) and weaver Bird *Ploceus philippinus* (Linnaeus) also depredate the grains at milky stage. Damage by both Fringillids and Ploceids commences from borders leaving the gaps in earheads but eventual feeding by former in middle is more than by later ones. Occasionally the *Lonchura* spp. also damages and differentiation is generally not possible excepting that at times portion of crushed grains remain on the earheads. Mode of damage by Psittacids, namely the *Psittacula krameri* (Scopoli) is noticeable by gnawed off portions of earheads lying below as well earheads cut off from the stalk (peduncle).

The data in table-3 revealed that quantified assessment of losses

Table 2 : Bajra Seed loss in different treatments of methiocarb

Treatments	Chemical in gms applied per mt	Av. no. seed loss per mt with weight in gm (brackets)	Seed loss in kg/ha	% increase due to treatments	% Avoidable loss
0.75% methiocarb seed dressings @ 0.2108 kg/ha (0.01581 kg a.i./ha)	1.581-93	17.2 (0.08959)	1.19	22.90	29.41
0.75% methiocarb seed treatment/dipping in hexanol	1.581-03	21.73 (0.11594)	1.33	13.63	15.78
0.25% methiocarb seed dressings @ 0.0702 kg/ha (0.00527 kg. a.i./ha)	0.527-03	19.14 (0.10013)	1.40	9.27	10.00
Untreated control	0.00	20.33	1.54		

Table 3 : Bird damage in Bajra variety - estimations on basis of percentage earheads damaged, frequency of damage and yield estimations at harvest

Sl. No.	Total ear-heads (Average)	Visual Estimations (in replicates of 12 mt each)								
		Frequency of damage								
		% Grain bearing ear-heads	% Grain ear-heads	% damaged ear-heads	% ear-heads undamaged	% randomised ear-heads examined for frequency damage	% ear-heads damaged	% ear-heads damaged 25%		
1	2	3	4	5	6	7	8	9		
1.	214.00	82.38	17.61	39.76	41.30	49.22	27.88	22.69		
2.	209.25	84.51 (86.43)	15.48 (15.83)	34.01	49.75	68.11	8.63 (6.23)	15.00 (10.84)		
3.	214.75	75.11	21.90	33.24	40.68	63.45	16.31 (12.65)	5.13 (3.98)		
4.	193.25	74.87	25.12	35.31	39.55	69.54	12.5 (8.84)	10.17 (7.20)		
3.	185.50	82.39	17.60	48.08	34.41	58.37	19.00 (16.02)	13.81 (11.65)		

Yield estimations (at harvest)

Sl. No.	% ear-heads 50% damaged	% ear-heads 75% damaged	% ear-heads 100% damaged	Yield loss due to completely damaged earheads	Economic loss			
					Yield loss (Q/ha)	Yield loss (Q/ha)	% obtain- ed	% yield loss
	10	11	12	13	14	15	16	17
1.	10.39	24.10	27.39	10.25	35.68	20.79	14.89	58.27
2.	26.01 (18.80)	18.51 (13.38)	39.34 (28.43)	13.81 (9.98)	48.74	29.80	18.94	61.14
3.	16.73 (12.98)	39.47 (30.62)	24.91 (19.32)	11.81 (9.16)	31.72	22.68	9.04	71.49
4.	24.27 (17.18)	30.70 (21.47)	38.81 (27.47)	13.76 (9.74)	29.56	23.20	6.35	78.49
5.	12.55 (10.58)	14.69 (12.38)	22.04 (27.02)	11.50 (9.69)	30.20	22.87	7.32	75.73
								24.26

Figures in parentheses are computed values on numbers as in horizontal column

Table 4 : Spray treatments with feeding repellents and deterrents to reduce bird damage at earheads

Sl. Treatments No. Spray fluid @4.2 cc/mt	Protected condition (unexposed to birds)					Unprotected conditions (exposed to birds)						
	Total earheads per mt. (Ave- rage)	Av. yield unpro- tected earhead (in gm)	Yield protected ear head/ mt. (in gm)	Yield Q/ha pro- tected condition	Total earheads completely damaged per mt	% completely damaged earhead per mt.	% yld (gm) ob- tainable per mt	Yield (Q/ha)	Yield (Q/ ha)	% Avoidable loss	% increase due to treatments	
1. 0.75% methio- carb spray (0.042 gm chemical WP/mt or 0.560 kg/ha 0.42 kg a.i. per ha)	17.83	10.57	267.67	35.68	0.77	4.03	95.96	20.79	14.89	19.28	3.96	
2. 0.375% methio- carb spray (0.021 gm. chemical/mt 0.28 kg. per ha. and 0.21 kg a.i./ha)	17.44	17.41 (17.80)	365.57 (373.80)	48.74	1.15 (1.1)	6.59 (6.74)	93.4 (95.50)	29.80	18.94	36.44	10.10	

3. 0.75% Malathion spray (0.063 cc/mt; 0.84 kg/ha 0.63 ltr. a.i.)	17.90	13.54 (13.48)	237.94 (237.05)	31.72 (0.98)	5.48 (5.46)	94.51 (94.16)	22.68	9.04	60.12	15.07
4. 0.375% Tetramethyl thiram disulphide spray (0.042 gms. W.P. mt)	16.10	14.09 (15.60)	221.75 (245.54)	29.56 (1.03)	5.69 (6.30)	94.30 (104.42)	23.20	6.35	72.60	26.49
5. Untreated	15.46	14.78 (17.04)	226.51 (261.27)	30.20 (1.11)	6.24 (7.20)	93.75 (108.14)	22.87	7.32	67.95	21.20

C.D. at $P=0.05$ 3.49; $P=0.01$ 3.26

Figures in parentheses are computed figures to bring parity with total number earheads in Col. 3 item No. 1

made by visual estimations does not reveal very true index. The extent of losses considerably vary due to various parameters, namely the total number of earheads, percentage of grain bearing, green, damaged and undamaged earheads. Further within damaged earhead (col.6), the frequency of damage considerably vary (col.7-12). However, observations on the frequency of damage when computed to uniformity (entry no. 1 in col.6) revealed that there is no statistical difference in total yield loss due to completely damaged earheads (col.12). The data, therefore, conclusively show that appraisal of bird damage as taken by total per cent damaged ear heads (col. 4 and 5) does not hold good in as far as the crop is concerned. Mathematical computations further elucidate another point *i. e.*, average per cent number of completely damaged ear heads (col.12) ranged from 19.32 to 28.43. Accordingly number of totally damaged earheads will come to 25 per cent. This is a grotesquely wrong figure as actual yield estimates show a loss of 18.94 Q/ha. These points deserve mention as there is a considerable dearth of guidelines on methodologies for appraisal of bird damage. Therefore, further studies should take into consideration these points.

The data in Table-3, however, on yield estimates show that per hectare yield loss could range as high as 6.35 to 18.94 Q/ha. These could amount to loss of Rs. 600/- to 1800/- approximately per hectare in terms of economic loss. This, therefore, affirms the observations of Jotwani *et al.*, (1969) that in many areas farmers prefer to cultivate the crop for fodder purposes only.

Control of bird damage at grain maturity

The data in Table-4 show that there is no statistical difference in average number of earheads/mt and average yield per earhead. Likewise, under treatments with both repellents and deterrents there is no statistical differences. However, on comparison with yield under protected conditions (col. 6) and exposed conditions (Col. 10) the least loss was in treatment with 0.375% Tetramethyl thiram disulphide. The range in other treatments was 7.32 to 18.94 Q/ha. On comparison with yields under untreated and treated plots, the treatment with TMTD showed increase due to the treatment followed by untreated check (21.20%). This however, needs further toxicological and residue studies.

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REFERENCES

- Beri, Y.P., M.G. Jotwani, S.S. Misra and D. Chander, 1968. Studies on relative bird damage to experimental hybrids of Bajra. *Indian J. Ent.*, **31** (1) : 69-71.
- Bhatnagar, R.K., M.G. Jotwani and M. Raizada, 1974. Screening of Bajra varieties for relative damage due to birds. *Ent. Newslett.*, New Delhi, **4** (10) : 55.
- Bhatnagar, R.K. 1976a. Significance of Bird Management and control. *Pesticides* (Annual, 1976) : 74-83.
- Bhatnagar R.K. 1976b. Bird pests of Agriculture and their control. *Proc. Nat. Acad. Sci. India*, 46-B (I & II) : 245-251.
- Bhatnagar, R.K. (1980). Studies on Bird depredations and their control in certain Agricultural crops, Ph. D. Dissertation. Instt. of Advance Studies, Meerut University, Meerut.
- Crase, T. Frederick and Richard W. Dehaven, 1976. Methiocarb : its current status as a Bird Repellent. *Proc. 7th. Vertebrate Pest control Conference-1976* : 46-50.
- Fitzwater, W. O. and Ishwar Prakash, 1979. Handbook of Vertebrate Pest Control, I.C.A.R., New Delhi 92 p.
- Guarino, J.L. and James E. Forbes, 1970. Bird damage of sprouting corn with a carbamate repellent. *New York Fish & Game Journal*, **17** (2) : 117-120.
- Jain, M.B. and Ishwar Prakash, 1974. Bird damage in relation to varietal differences in Bajra crop. *Arid Zone*, **13** (2) : 139-141.
- John. G. Rogers, 1974. Responses of caged Redwinged Black Birds to two types of Repellent. *J. Wildl. Mgmt.*, **31** (3) : 418-423.
- Jotwani, M.G., Y.P. Beri and K.K. Verma, 1969. A note on Bird damage to millets. *The Allahabad Farmer*, XLIII (1) : 43-44.
- Mehrotra, K.N., Y.P. Beri, S.S. Misra, and A. Phokela, 1967. Physiological effects of Malathion on House Sparrows *P. domesticus* L. *Indian J. Exptl. Biology*, **5** (14) : 219-22.

Mehrotra, K.N. and Bhatnagar, R.K. 1979. Status of Economic Ornithology in India : Bird depredents, Depredations and their management. ICAR, New Delhi : 1-79.

Pardee, W. 1979. Lessons from-74'. *American Agric.*, December : 4.

Rogers, John G. Jr. 1974. Responses of caged Redwinged black birds to two types of repellents. *J. Wild Life Mgmt.*, **38** : 418-432.

Schaffer, E.W. Jr., R.P. Starr, D.J. Cunningham and T.J. Decino, 1967. Substituted phenyl N-Methyl Carbamates as temporary immobilising agents for Birds. *J. Agri. Food Chem.*, **15** (2) : 287-289.

Singh, Ambica, 1980. Cropping patterns, pp. 248-262. In P. L. Jaiswal and A. W. Wadhvani (eds.), *Hand Book of Agriculture*, Indian Council of Agricultural Research, New Delhi.

West, R.R. and J.M. Junks, 1969. Repelling Boat-tailed Grackles from sprouting Corn with a carbamate compound. *Texas Jour. Sci.*, **21** (2) : 231-233.

West, R.R., R.B. Bruntan and D.J. Cunningham, 1969. Repelling Pheasants from sprouting Corn with a Carbamate Insecticide. *J. Wild Life Mgmt.*, **33** (1) : 216-219.

CONTROL OF BIRD DAMAGE AT SOWING STAGE IN BARLEY AND ITS EFFICACY IN CONTROL OF OTHER PESTS

R.K. BHATNAGAR AND VIDYA SAGAR SINGH

Introduction

In most crops depredations by aves at sowing stage could be significantly high. In case of barley, Mehrotra and Bhatnagar (1979) and Bhatnagar (1980) have reported numerous species, notably the Columbids, Pheasants and Ploceids which may affect depredations on broadcasted and seed sown in furrows. Field studies have revealed that unless seed loss is controlled in areas close to sanctuaries like Bharatpur in Rajasthan, resowing will have to be done (Bhatnagar, 1980). In such areas and elsewhere, the depredatory species affecting losses at sowing comprise species with dual economic status. Therefore, protection from seed loss will have to be with an approach that has the least lethal effect on involved species and that affords protection against other pests. Seed treatments with chemical repellents which affect feeding aversions (Roger, 1964) offer promise in India (Bhatnagar, 1980) as show least ill effects and practically no mortality. With this view in mind the study was undertaken.

Material and Methods

Replicated field trial was undertaken at the farms of Indian Agricultural Research Institute, New Delhi during the rabi season of 1980-81 on two varieties (DL 150) hulled and hull-less (1865) on recommended agronomical practices (Jain, 1980). Germination viability was tested in simulated laboratory conditions and the data are given after deducting the found viability index (2%) in self explanatory tables. Counted seeds were sown in seed furrows. Seed loss due to birds was recorded by presence of 'pecking' or marks of 'digging' or 'scratching' by claws of

birds. Observations on visitant depredatory species were recorded periodically during morning (3 hr.), daytime (2 hr.) and late afternoons (2 hr.). Population counts of visitants was not taken into account as from a distance it was impracticable to indicate visitants on any particular plot simultaneously in both the varieties. However, visitants were recorded.

Results

Studies indicated that dominant avian depredatory species in Delhi region comprised Columbids, *Columba livia* (Gmelin) and *Streptopelia decaocto* (Frivald.). These affect losses to sown seeds till sprouting stage and also affect losses in furrows the seed has not been covered with raked over earth. Feeding is continuous till the birds are scared. Periods of their abundance are usually in morning, late afternoon and also during daytime. General abundance of *Streptopelia* spp, is in varying densities. *Sturnus vulgaris* (Linn.) in small flocks rarely affected the plots, but whenever the species settled, feeding was faster than in other species. *Passer domesticus* (Linn.) was observed affecting depredations to seeds that have not been covered with raked over earth. At sprouting, *Corvus splendens* (Vieillot) and *Corvus macrorhynchus* (Vieillot) did not show regular abundance but affected losses by pulling out the soft sprouting grains. Losses due to birds could easily be differentiated by presence of marks indicating their activities.

Depredation by aves and its control

Data in Table-1 showed that in hull-less variety, losses due to birds ranged from 13.22 to 46.89 per cent till 33rd day of sowing when complete germination had taken place. Loss (46.89%) was highest in untreated. Seed treatment with 0.75% methiocarb in tanin solution showed 13.22% losses, being lowest. All the other treatments showed less losses than in untreated plots.

In hulled variety, losses till 33rd day ranged from 16.72 to 61.89 per cent, being the lowest and the highest respectively, in seed dressings with 0.75% methiocarb and the untreated. Statistically differences were significant and losses in seed dressings with 0.75% methiocarb and 2% carbofuran were at par.

Table 1 : Number of seedlings in various treatments at different intervals.

Treatments	Hull-less		Hulled	
	10th Day	33rd Day	10th Day	33rd Day
	ave. No./ plot present	Loss (%)	Ave. no. plot present	Loss (%)
T-1. 0.75% Methiocarb	55.00	28.06	50.83	16.72
T-2. 0.375% Methiocarb	60.44	26.06	52.61	30.78
T-3. 0.75% Methiocarb in Tanin	49.44	13.22	45.72	23.78
T-4 5.0% Genetian Violet	49.44	24.56	40.88	60.84
T-5. Untreated control	41.38	46.89	39.50	61.89
T-6. 2.0% Carbofuran	58.30	33.40	52.61	18.67
SEM±	19.53904	52.25850	37.211	27.86374
CD 5%	58.0556	164.6596	117.247	87.8075

Seedling damage by *Gryllotalpa* spp.

In hull-less variety number of damaged seedlings ranged from average 46.33 to 201.66. Between 7th to 24th day of sowing, losses by cutting away of tillers were 46.33, 65.33, 81.33 and 58.33 respectively, in seed dressings with 0.75%, 0.375%, 0.75% methiocarb with tanin and 2.0% carbofuran. Maximum number of tillers were damaged in treatments with Genetian violet and the untreated. Plant stand was the highest in carbofuran treatment followed with treatment with methiocarb. While in untreated and genetian violet treatments, the plant stand respectively come to 2826.00 and 4953.00.

In hulled variety, number of damaged seedling ranged from 42.00 to 248.00. Least number of damaged seedlings were in seed dressings with 0.75% methiocarb in tanin solution, followed with average 43.00 in 0.75% methiocarb dressings and 46.33 in 2.0%, Carbofuran dressings. While losses due to cutting of tillers in Genetian Violet

treatment and untreated, it respectively came to 248.00 and 237.00. Statistically these were at par. Similarly, lowest plant stand per plot were 2817.00 and 2517.00 respectively in Genetian violet treatment and untreated. All the other treatments showed higher plant stand, highest being 5946.00 in 2.0% Carbofuran dressing. Statistically the differences within treatments were significant.

Discussion

Appraisal and control of avian depredations in Barley at sowing had so far been wanting. Bhatnagar and Singh (1981) reported that these

Table 2 : Average number of damaged (by *Gryllotalpa* spp.) and healthy shoots in various treatments.

Treatments	Hull-less		Hulled	
	7-24 day		7-24 day	
	Ave. no. tillers cut/plot by <i>Gryllotalpa</i> spp.	Plant stand Ave./ plot	Ave. no. tillers cut per plot by <i>Gryllotalpa</i> spp.	Plant stand Ave/ plot.
T-1	46.33	6946.00	43.00	5781.00
T-2	65.33	6537.99	63.00	5661.99
T-3	81.33	6747.99	42.00	5862.00
T-4	195.66	4953.99	248.00	2817.99
T-5 (UT)	201.66	2826.00	237.00	2517.99
T-6	58.33	7479.99	46.33	5946.00
SEM±	34.9750	16.70395		
CD 5%	110.20165	52.63196		
CD 1%		74.86118		

Legend to abbreviations in Column-Treatments :

T-1, Seed dressings with 0.75% methiocarb ; T-2, seed dressings with 0.375% methiocarb ; T-3, seed treatment with 0.75% methiocarb in 30% tanin solution (Acacia bark) ; T-4, seed treatment with 5.0% Genetian violet ; T-5, untreated control and T-6, seed dressings with 2.0% Carbofuran.

could be significant and studies on control deserves attention with repellent treatments. Singh and Ramachandran (1981) reported that at sowing seed germination is also affected by *Gryllotalpa* spp. and control approaches were suggested. However, studies on control of avian depredations with feeding repellents that had least effect due to their physiological effects (feeding aversions) and which simultaneously provide protection were wanting. Methiocarb affecting feeding aversions and in consequence showing least lethal effects on depredatory aves in well reported (Schaffer *et al.*, 1967, Mehrotra and Bhatnagar, 1979 and Bhatnagar, 1980). This point deserves consideration especially in case of Barley crop which is cultivated in regions widely affected by endangered or protected avian species which affect depredations in the crop (Ali and Ripley, 1974 and Bhatnagar, 1980).

Present studies have revealed that efficacy of Methiocarb seed dressings especially with tanin solution offers comparable protection against avian depredation and the insect pest at sowing to that afforded by toxic compound, the 2.0% Carbofuran. The latter compound has 'knock down' effect if 2 to 5 treated grains are ingested. Genetian violet affects protection due to aversive colour responses and appears similar in action to Methyl Green. The later has been suggested by Fitzwater and Prakash (1973) for exposed rodent baits as protectant against picking by birds. Genetian violet treatment is however, ineffective in protecting seedlings against *Gryllotalpa* spp. Methiocarb and Carbofuran treatment are effective in controlling damages both by birds as well as the *Gryllotalpa*. Methiocarb seed dressings thus appear to offer promise for uses in areas where endangered bird species are involved and which are depredatory at sowing stage.

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REFERENCES

- Bhatnagar, R.K. 1980. Studies on avian depredations and its control in certain Agricultural Crops. Ph. D. Dissertation, Meerut University, Meerut.

Bhatnagar, R.K. and Singh, V.S. 1981. Bird damage in Barley and its control. Abs. *National Seminar on Strategies for pest management*, I.A.R.I., New Delhi, Dec., 1981., p. 22.

Mehrotra, K.N. and Bhatnagar R.K. 1979. Status of Economic Ornithology in India. Depredants, depredations and their management. ICAR, New Delhi. 79. pp.

Jain, K.B.L. 1980. 'Barley' in Hand book of Agriculture. ICAR, New Delhi. pp. 801-815.

Roger, J.G. Jr. 1964. Responses of caged Redwinged Black Birds to two types of repellents. *J. Wild Life Mgmt.*, 38 (3) : 418-432.

Schaffer, E.W. Jr., R.I, Cunningham, D.J. and Decino, T.J., 1967. Substituted phenyl N-methylcarbamates as temporary immobilizing agents for birds. *J. Agr. Food Chem.* 15(2) : 287-289

Singh, Vidya, S. and Ramachandran, R. 1981. Seed treatment of Barley for Aphid and Disease control. Abs. *National Seminar on Strategies for pest Management*, IARI, New Delhi, Dec. 1981. p. 21.

EFFICACY OF SOME BIRD REPELLENT IN SORGHUM AT MATURITY STAGE OF CROP

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M.G. JOTWANI AND V.T. GAJBHIYE*

Introduction

The depredatory species at grain maturity are mainly Fringillids viz., Munias, *Lonchura punctula* (Linnaeus), Ploceids viz., house sparrows, *Passer domesticus* (Linn.), weaver bird, *Ploceus philippinus* (Linnaeus), Psittacids viz., *Psittacula krameri* (Scopoli), Corvids, *Corvus* spp. and Columbids, specially *Streptopelia decaocto* Frivaldsky. These species perch on the earhead stalk and depredate the grains. However, dominance of Ploceids is maximum. Two recently introduced bird repellents viz., Landrin and methiocarb along with malathion and three decoctions of plant origin were tried for their relative efficacy against these birds.

Material and Methods

A trial was laid out during 1981 in the farm area of the Indian Agricultural Research Institute with ten treatments each replicated four times. A sub-plot consisted of 4 rows, each row measuring 3 metres long. The row to row and plant to plant distances were maintained at 75 cm. and 15 cm, respectively. The crop was protected from shoot fly, *Atherigona soccata* (Rondani) damage by carbofuran 3G granular insecticide which was applied in bands in seed furrows at the time of sowing @2.0 g/m row. Later on for protecting the crop from another tissue borer *Chilo partellus* (Swinhoe), endosulfan 4% G were applied in the whorls @ 8, 10, 12 kg/ha on 20, 30 and 40 days after germination, as per recommendation of Jotwani *et al.*, 1971. At the maturation stage, when damage by birds has just started, crop was sprayed with methiocarb @1.0, 1.5 and 2.0 per cent concentration and Landrin @ 0.375, 0.75 and 1.5 per cent

concentration. Besides these chemical bird repellents, three non toxic decoctions of *Acacia* bark, Walnut bark and tea plus red edible dye were also included. These compounds were selected on the basis of pan tests carried out for foraging and feeding aversions. At the time of harvest twenty five spikelets per five plants from each row were taken for calculating percentage damage and average percentage loss are presented in Table 1.

Table 1: Efficacy of repellent sprays for control of bird damage at grain maturity in sorghum (Hybrid variety CSH-5) Figures in parentheses are transformed values/arc-sine/percentage

T.	Treatment	Average % grain loss after spray	Residues (at harvest) (in ppm)
T ₁	Landrin 1.5% spray	21.46 (27.50)	0.44
T ₂	Landrin 0.75% spray	29.32 (32.72)	0.226
T ₃	Landrin 0.375% spray	30.61 (33.58)	8.140
T ₄	Malathion 2% spray	10.95 (19.32)	1.17
T ₅	Methiocarb 1.0%	21.62 (27.71)	0.33
T ₆	Methiocarb 1.5%	13.29 (21.38)	0.81
T ₇	Red dye+Tea decoction	21.44 (27.59)	—
T ₈	Walnut bark decoction	15.22 (22.16)	—
T ₉	Acacia bark decoction	13.57 (21.61)	—
T ₁₀	Control (No treatment)	00.24 (71.83)	—

SEM $\pm$ (0.25), CD at 5% (0.74), CD at 1% (1.00)

Analysis of Landrin residues in grain

Seed samples were ground to 1 mm size by Willy Mill extracted with methylene chloride using soxhlet apparatus. Extracts of Landrin were cleaned by coagulation technique (Miskus *et al.*, 1959). Extracts of methiocarb were cleaned by passing through an absorbent column containing charcoal and celite (1:1). Residues in the cleaned extracts were analysed by electron capture gas-liquid chromatography after hydrolysing landrin with alkali and coupling the phenol with 1 fluoro-2, 4-dinitro-benzene. A traçor MT-20 model Gas Chromatograph equipped with Ni⁶³ detector was used. The parameters were: Column 3% OV 210 on Chromosorb-W (HP); temperature (O) inlet

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260, column 250, detector 275 : gas flow (nitrogen) 100 ml/min. 3 µl sample was injected.

RESULTS AND DISCUSSION

It is seen from the data in Table that all the treatments were found effective in reducing the bird damage in comparison to untreated control. Amongst the treatments, average percentage loss varies from 10.95 (malathion 2% spray) to 30.61 (landrin 0.375). In control 90.24% loss was recorded. Besides chemical bird repellent, three non-toxic compounds were tested viz., red dye+tea decoction, walnut decoction and *Acacia* bark extraction. These earlier tested as pan tests have indicated 'foraging and feeding behaviour aversions' when seeds with such treated compounds were provided. Amongst various decoctions, in *Acacia* bark extract the minimum percentage loss of 13.57 was recorded followed by walnut bark and red dye with tea decoction. Both the concentrations of methiocarb were found to be effective. The minimum loss 13.29% amongst these treatments were recorded where methiocarb sprayed at 1.5% concentration. In the landrin treatment 0.44 ppm level of residue provided 21.46% grain loss at harvest whereas 0.140 ppm level of residue provided only 30.61% grain loss.

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REFERENCES

- Miskus, R. Gordon, H.T. and George, D.A. 1959. Colorimetric determination of Sevin in Agricultural Crops. *J. Agric. F. Chem.*, 7; 613-614.
- Holden, E.R. 1973. Gas chromatographic determination of residues of methyl carbamate insecticides in crops as their 2,4 dinitrophenyl ether derivatives. *J. Assoc. Chem.*, 56 : 713-717.
- Jotwani, M.G., Dinesh Chandra, Young, W.R., Sukhani, T.R. and Saxena, P.N. 1971. Estimation of avoidable losses caused by insect complex of sorghum hybrid CSH-1 and percentage increase in yield over untreated control. *Indian J. Ent.*, 33 (4) : 275-383.

PLANT IDEOTYPES AND OTHER COLLABORATIVE MEASURES FOR CONTROLLING BIRD DAMAGE IN RAINFED REGIONS

NARESH MEHROTRA*

Introduction

Rainfed regions of India (75% of the cultivated area) with a variety of agroclimates, raise Pulses (pigeonpea, mungbean, moth bean, chickpea and lentil), oilseeds (groundnut, sesame, mustard and rapeseed), cereals (upland paddy and wheat), millets (cluster bean, cotton, castor and linseed). Even with low productivity (reason : erratic rainfall distribution and quantum during crop season and poor management (Mehrotra, 1980a), food crops contribute approximately 40 per cent of national food. This necessitates the stability of increased productivity/production of rainfed crops (Mehrotra, 1980b).

Wide spread poverty and poor health of men and animals and their increasing birth rate create keen competition for some agro-ecosystem and vicious circle so formed for subsistence agriculture needs break. This trend for a considerable duration resulted in over exploitation of agro-ecosystems. Consequently, deteriorating socio-economic status of rainfed regions has created a gap between them and farmers from irrigated areas. This gap can be bridged by evolving and extending economically sound agro-production techniques for different rainfed conditions and regions. There are many aspects of developing and extending these technologies (Mehrotra, 1980 b, c, d). This approach will suggest plant ideotypes in different crops thereby aiming to reduce bird damage because of its stable economic potential in increasing agro-productivity and in reducing the frequency of hazards to civil and defence aviations. This aspect is also important because of increasing supersonic aviation. Apart from this, suggestions will be for multi-disciplinary approach and future research for augmenting desirable trends.

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Plant ideotypes in controlling bird damage

The guiding principle for this approach is to reduce damage by distracting birds from crops to suitable alternative. Another view point expresses the significance of birds' for stable and useful eco-systems besides developing aesthetic sense. Therefore, bird killing though is undesirable, yet extinction/danger of extinction of certain species of birds by indiscriminate killing, deforestation and intensification of industries is increasingly evidenced. Clearly, these approaches have disturbed compositions of bird populations because it is related to the delicate balance of tier-systems for food and shelter (Dobzhansky, 1951). This is disturbed in agricultural and/or industrial developments.

This incorporation of following plant character in crop is useful for reducing bird damage :

1. Bristles/awns in millets/ cereals/sun-flowers are effective bird distractors. Awn length varies considerably. Apart from this, awns contribute to photosynthesis and yield.
2. Thorns/spines also safeguard crops from bird damage. The range of variation for length and intensity of spines is considerable in safflower (Ashri, 1973 ; Weiss, 1971) and Castor (Weiss, 1971). This expression in other crops can not, be ruled out. Therefore, studies in species of 'problem birds' for determining requisites of length and intensity of thorns/spines is desirable.
3. Pest resistant varieties of crops would be another source for avoiding bird damage because their dependence on these pests and alternatively on crops is not ruled out. Therefore, with defensive measures and pest resistance, these birds will be diverted to seek other sources of food.

The above mentioned characters suggest the significance of multi-disciplinary research approaches, for reducing avoiding bird damage to crops. Clearly, coordination of plant breeders and entomologists will be rewarding in this respect.

Other collaborative measures

The following collaborative measures appear desirable in reducing bird damage :

1. Since disturbed tier-systems of most ecosystems is commonly observed, therefore, studies in the region wise differences of

compositions of bird populations and also the possibilities of alternative ecosystems are warranted. This is in tune with alternate land use in rainfed regions (Swaminathan, 1970; Reddy and Hampaiah, 1981). It carries the potential of reducing bird damage by providing them alternative habitats. This approach will certainly require testing of diversified plant material for identifying adoptable technologies for rainfed regions.

2. The main source of bird damage to aviation comes from kites and hawks. Consequently, high speed of aeroplanes and heavy body weight of these birds often make damages of glass windows serious. These call for the consideration of following measures :

- (a) Stretch of crop fields around aerodromes, because most of 'problem birds' are carnivorous.
- (b) By law, slaughter houses inviting these birds should be located at safe distances from aerodromes.

It is true that hazards due to 'problem birds' are disastrous but equal truth is that providing solutions for reducing these damages are available. It is hoped that the above mentioned remedial measures could be of some use in achieving this objective.

REFERENCES

- Ashri, A. 1973. *Divergence and evolution in safflower genus, Carthamus*, L. Final Res. Rept., pp. 180. The Hebrew Univ., Jerusalem, Rohovot, Israel.
- Dobzhensky, Th. 1951. *Genetics and origin of species*. Oxford Book Co., New Delhi.
- Mehrotra, Naresh, 1980a. *Management as non-cash input in increasing productivity in rainfed regions*. Paper presented in the symposium 'Role of non-cash monetary input management in Dryland Agriculture', Haryana Agricultural University, Hissar, India.
- Mehrotra, Naresh, 1980b. Coordinated approach for stabilising agricultural production in semi-arid tropics Approach Papers 2 : 153-159. *Proc. Intern. Cong. Dryland Fmg.* Adelaide, Australia.
- Mehrotra, Naresh, 1980c. The constraints in the transfer of rainfed agro-technology and priority in agricultural development. *Pros-*

pective Agricultural Geography, 2 : 427-43 (edt. Noor Mohammad), Concept Publ. Co., New Delhi.

Mehrotra, Naresh, 1980d. *Safflower breeding and its prospects in India* (invited paper) *Proc. the use of induced Mutations for the Improvement of Oil seeds and other Industrial Crops*. FAO/IAEA, International Atomic Energy Agency, Vienna, Austria (in Press).

Reddy, N.V. and Hampaiah, R. 1981. Alternate land use in dryland agriculture. : 74-89. *A decade of Dryland Agricultural Research in India, 1971-80*. All India Coordinated Research Project for Dryland Agriculture, Hyderabad.

Swaminathan, M.S. 1970. Preface in "*A new technology for Dryland Farming*," Indian Agricultural Research Institute, New Delhi.

Weiss, E.A., 1971. *Castor, Sesame and Safflower*, Leonard Hill Books, London.

RESISTANCE TO BIRDS IN DIFFERENT GENOTYPES OF BAJRA (*Pennisetum typhoides*)

PREM KISHORE AND R.K. BHATNAGAR

Many species of birds feed on developing or mature grains of bajra and sometimes they damage bajra crop so heavily that farmers are unable to get profitable harvest from this crop. The damage caused to bajra by birds is largely due to spilling of grains while feeding. Different areas of the country have different bird problem. In general, in India the bird complex comprises of doves, pigeons, parakeets, 'baya' sparrows and 'munias' which inflict heavy losses to bajra grains.

Over the period of two years from 1981 to 1982, twenty one high yielding genotypes of bajra in advance stage of testing prior to release for commercial use were screened for bird resistance at Indian Agricultural Institute, New Delhi-110012, for their relative susceptibility to bird complex. The parameters used for screening were visual grading of earheads for bird damage following 0 (no damage) to 9 (very severe damage) and the amount of grain damaged per 5 earheads. Data is given in table which self explanatory.

Three entries viz., MBH-110, MH-88 and MH-36 were found free from bird damage.

Table 1 : Reaction of different bajra genotypes to bird damage

Varieties	Per cent Grain damage		Av. Visual Grading	
	1980	1981	1980	1981
MCP-76	16.95	18.52	2.2	4.0
WC-B-77	14.16	16.70	3.0	3.0
WC-C-75	22.45	25.34	3.0	3.0
MH-59	14.78	25.75	4.5	5.0
MH-1	31.96	16.85	4.0	2.5
MH-32	12.63	15.95	5.0	3.0
MH-88	0.00	0.00	0.0	0.0
MH-3	19.02	22.00	4.5	5.5
MH-23	27.08	25.20	5.0	5.5
MH-36	0.00	0.00	0.0	0.0
MP-5	21.45	26.50	5.5	4.5
MP-17	32.53	45.75	5.5	7.5
MP-20	22.14	25.65	3.5	4.5
MP-31	16.95	18.95	3.5	5.0
MP-8	19.03	15.25	4.5	3.0
MP-37	22.79	18.75	3.5	2.5
MBH-110	0.00	0.00	0.0	0.0
ICMS-7817	12.35	15.70	2.0	2.5
GHB-45	33.17	36.00	6.0	6.0
PSB-8	14.25	18.00	3.2	4.5
ICH-241	10.00	15.00	2.0	4.0
SEM±	130	2.24	0.53	0.52
CD at 5%	3.79	9.61	1.53	1.50

BIRD DAMAGE TO MAIZE COBS—RELATIONSHIP BETWEEN SUSCEPTIBILITY OF MAIZE GERMPLASMS AND SPATHE CONFIGURATION

R.K. BHATNAGAR, PRAKASH SARUP, K.N. MEHROTRA, M. RAIZADA, K.K. MARWAHA, V.P.S. PANWAR AND K.H. SIDDIQUI

ABSTRACT

Throughout the maize growing tracts, maize cobs both at milky stage and at maturity are subjected to severe avian depredations. Besides the commonly employed method of crop protection from birds, the use of maize varieties resistant to not only insect pests and diseases but also to birds will fit better in the overall economy of maize cultivation. This led to evaluate the susceptibility of 49 maize germplasms (Introduction Nursery) to birds at the farm of Indian Agricultural Research Institute, New Delhi. The dominant depredatory bird species comprise psittacids and corvids. On the basis of average per cent damage in cobs, the susceptibility of various germplasms was evaluated. Maize germplasms viz., Piralo Piracicaba, Suwan DMR Source I, D Composite and Piranao did not show any bird damage. Apparently, the height at which the cob was placed on the plant revealed that those borne at lower height (at 50 cm) were relatively less attacked by birds even at borders. The spathe configuration in the least susceptible germplasms showed that usually spathes completely covered the cobs and grains. Tightness of the outer-most spathe as also the compactness of inner spathes and their coverage over grains are important parameters affecting bird damage.

These bird resistant maize germplasms were, however, highly susceptible to the stalk borer, *Chilo partellus* (Swinhoe), as previously determined. On the other hand, clearly known least susceptible maize germplasms viz., Ganga 5 and Antigua Gr. I to *C. partellus* exhibited 45 and 58 per cent damage of cobs due to birds, respectively. The performance of Suwan 1 and Thai Comp.—4 in respect of both the insect and bird damage was promising, being least susceptible. These multiple sources of resistance would thus provide the much needed base in developing varieties resistant to aves and insect pests.

BIRD DAMAGE IN SOYBEAN AND ITS CONTROL

R.K. BHATNAGAR AND N.S. BHATTACHARJEE

ABSTRACT

The soybean crop is very much damaged by a number of birds of which the Columbids, wild pigeon (*Columba livia* [Gmelin]) and the dove (*Streptopelia decaocto* [Frivald]) are very important. They dig out the sown seeds and nibble the cotyledons of the sprouted ones. Their depredation sometimes become so serious that the whole crop require resowing. The common crow, *Corvus splendens* (Vieillot) also does a considerable damage to the crop by picking up the sprouted seeds.

The columbids traverse in a line picking the seeds from the furrows. They move on from seed to seed by proving pecks as well as by scratching the ground with claws to expose the sown seeds while the crows feed in patches by scratching the ground with claws.

It was found that increase in interseed gap did not help much in reducing the extent of losses to a significant extent. This was evident from the losses ranging from 32.5 to 45.83 per cent with decreased seed gap of 2-3 inches from seed to seed and 25 to 47.5 per cent in the increased seed gap of 4-5 inches from seed to seed.

Preliminary studies to control the depredation showed that seed dressing with 0.05 per cent Thimet (phorate) and 0.75 per cent methiocarb (4-Methylmercapto-3, 5 dimethylphenol N-methyl carbamate) are somewhat effective. In the former treatment the losses ranged from 20.28 per cent in decreased interseed gap to 22.36 per cent in increased interseed gap. With Methiocarb the losses ranged from 20.83 per cent in increased interseed gap to 28 per cent in decreased gap. Statistically effect of the treatments differed significantly in increased seed gap only and did not show such difference in decreased seed gap. This indicated that seed dressing with phorate and the repellent Mesurol could ward off the birds when the interseed gap is more.

RELATIVE SUSCEPTIBILITY OF CERTAIN 'BAJRA' VARIETIES TO AVIAN DEPREDAATORS

R.K. BHATNAGAR, M.G. JOTWANI AND K.N. MEHROTRA

ABSTRACT

Significance of studies on varietal susceptibility of crops to depredators need little introduction. In case of 'bajra' the subject has received little attention inspite of the fact that the crop is highly vulnerable to avian depredations. Available control methods have either shown limited efficacy or are often expensive. In 'bajra' already certain studies have shown that varieties with shed layer of anthers and awned varieties are less susceptible and their development could provide comparatively economical way of reducing losses due to birds.

Present study was undertaken in relatively lesser susceptible varieties of exotic and indigenous origin and awned, awnless, tall, medium and comparatively short varieties against high yielding indigenous variety. The varieties had earlier been screened out of 46 varieties and comprised HB-3, J-275 ; 88-964 ; 88-988, 88-980 ; studied to appraise varietal differences in relative susceptibility with a view to study physical plant characters that affect susceptibility due to birds. Attempts were made to study relevance of certain parameters generally taken by Ornithologists for assessing bird damage. Parameters studied comprised, percentage of damaged earheads; intensity of damage in earheads of early (tall) and late (short) tillers ; intensity of parakeet damage ; total intensity of damage by birds ; length of earheads ; plant height and number of grains per sq. cm. at tip, base of earhead and yield loss due to birds. These parameters were subjected to analysis of covariance and correlation regression analysis. Study revealed certain interesting points especially of varietal susceptibility against avian depredations

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many parameters may indicate less susceptibility but these differed with behavioural responses in context to locational effects and plant characters. Correlation coefficient ratios though showed weak correlations, yet indicated trends. They showed, intensity varied with maturity, plant height and availability of grains at tip of earheads. Earheads on lower plants were less vulnerable, compact small grains were less depredated than bold, exposed, less compactly placed. Variety with stiff stalk are less affected by parakeets. Awned varieties are less affected by ploceids and estrildids. For indepth appraisals of varietal susceptibility by birds, trials in large acreage coupled with evaluation of infestation intensity of visitants has been suggested.

BIRDS AS INDIRECT VECTORS OF PATHOGENIC FUNGI—PROBLEM BIRDS IN ANIMAL AND HUMAN HEALTH

S.B. MATHUR* AND R.K. BHATNAGAR**

The bird control and management has a great significance in problems relating to human, cattle and poultry health on one hand and contaminants in food, beverages, pharmaceutical, hospital, and hotels etc. on the other. Besides this, problem is also in homes and to Scientific personnels engaged in work on birds.

The birds as vectors of diseases are known since long. As early as 1880 and 1883, Louis Pasteur isolated cases of chicken pox, cholera and parrot fever. These diseases are transmissible from wild animals to human and are called *Zoonoses*. The diseases which are transmitted by birds are called *ornithosis*. These are generally spread through contamination with excrement by aerosol machanisms and by birds acting as intermediate harbouring true insect vectors.

These aspects can be discussed in the light of the following examples.

(i) *Psittacosis*: This was first thought to be transmitted by psittacine birds, but it is now reported to be transmitted by other birds as well. It causes respiratory disorders in human beings. The birds involved are like pigeons, sparrows, crows and mynas. This disease is also quite common in Australia and S. America and is an important tool in regulating the birds population itself (Hermann, 1966).

(ii) *Histoplasmosis*: This is caused by a fungus *Histoplasma capsulatum* which lives on decaying bird droppings of nearly all species. According to Price (1966), it does not grow on fresh poultry droppings.

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The spores have been isolated from the droppings of wild birds, too. (Emmons, 1961). The fungus causes lesions in the human beings, spleens and livers. It affects many wild and domesticated animals also (Price, 1966).

(iii) *Avian pox* : Common on domestic chickens it spreads due to contamination by visitants.

(iv) *Encephalomyelitis* : The virus is harboured by many bird species and transmitted to humans through vector like mosquitoes and ticks. Recently, encephalitis has been reported in India. The ticks are involved in the maintenance of this virus are *Haemaphysalis* sp. and *H. spinigera* and are also reported from India (Pande, 1964).

(v) *Salmonellosis* : This is caused by *Salmonella* sp. It is spread by droppings and contamination from feral as well as wild birds to human beings and cattles.

Besides these, there are other diseases, too which are spread by birds viz.

(a) *Foot and mouth disease* by starling. (Wilson and Matheson. 1952).

(b) *New Castle disease* in poultry by sparrows (Gustafson and Moses, 1973).

(c) *Transmissible Gastro enteritis*

(d) *Chronic respiratory disease* in poultry.

(e) *Bronchitis* by starlings.

Birds as Vectors of many ecto and endo parasites (March, 1962 also posesman a serious problem.

Studies on soil samples and decaying droppings of crows, sparrows, pigeons, Bengal vulture, white vulture and pariahkites have indicated the presence of micro-organisms. Further studies are being continued to find species affecting pathogenic conditions in animals, plants etc.

REFERENCES

- Emmons, C.W. (1961). Isolation of *Histoplasma capsulatum* from soil. Washington D.C. Publ. Heth. Rep. Washington. 75 : 362-364.
- Gustafson, D. Pard, and H.E. Moses (1973). The English sparrow as a natural carrier of New castle disease virus. *Am. J. Vet Res.* 14 : 581-585.

Hermann, M. Cartton (1966). Diseases in birds. pp. 450-467. In recent trends in Avian Biology, Chicago Univ. Press.

March, G.A. (1962). Birds borne diseases (Unpubl.) presented at 1st Birds Control Seminar Bowling Green Univ., Ohio.

Pande, B.P. (1964). Veterinary Entomology. In Entomology in India 1938-1963. *Indian J. Ent. Sup.* pp. 456-464.

Price, E.R. (1966). Histoplasmosis. Its relationship to birds pp. 1-8. In Proc. 3rd. Bird Control Seminar Bowling Green State Univ. Ohio.

Wilson, W.W. and R.C. Matheson (1952). Bird Migration and foot and mouth disease. *Agriculture, London.* 59: 213-228.

DENSITY, DIVERSITY AND FEEDING BEHAVIOUR OF PADDY FIELD BIRDS

SHAKUNTHALA SRIDHARA, M. V. V. SUBRMANYAM AND R. V.
KRISHNAMORTHY

ABSTRACT

Bird damage to crops, particularly cereals is a world wide phenomenon with damage afflicted from sown seeds through sprouts to mature earheads. In the present study data was collected on the density, diversity, spatial and temporal distribution and feeding behaviour of paddy-field birds during *Kharif* and *rabi* 1980-81. Density was highest during heading and least during tillering while diversity was greatest during harvest and least during preharvest. Of 30 species foraging paddy fields, only 5 species were grainivorous and were abundant during harvest time. Munia and baya fed directly from the earheads, the former in flocks and the latter in pairs. Pigeons and doves were ground feeders, eating fallen seeds. Parakeets depredated more on a patch of sunflower in the study area than on paddy. Wagtails, myna, drongo, rollers, swifts and swallows were the major insectivores exhibiting diverse spatial and temporal distribution. Egret, heron, kites, kingfishers, plover and ibis were the carnivores, seen mostly during early stages of paddy cultivation.

BIRD DAMAGE IN SAFFLOWER

Y. MAHTO AND R.K. BHATNAGAR

ABSTRACT

In India, Safflower, *Carthamus tinctorius* Linn. is cultivated in 590,000 hectares and the yield is estimated around 130,000 tonnes. The crop is gaining importance due to varied usage of oil and as its cultivation on border rows is also useful in checking intrusion/tresspass of stray cattles and movements of rodents to some extent. The crop is, however, vulnerable to parakeets *Psittacula* spp. Therefore, studies were undertaken on depredations on four varieties comprising two spiny (116-4-5 & JSF-1) and two soft varieties (NS-133 and 340092). The data given in the table reveals that the spiny varieties are less susceptible than the soft or varieties with less spines on bolls.

Table—Parakeet damage in Safflower

Varieties	Av. % Bolls taken away	Av. % Bolls gnawed	Av. % Bolls damaged
JSF-1	2.23	16.25	18.16
116-4-5	3.43	19.81	23.25
NS-133	19.54	40.71	61.09
340092	17.42	40.55	57.98

Studies besides dealing behaviour and population of visitant aves have also revealed that relative susceptibility to parakeets in these varieties is irrespective of plant height and the maturity.

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16,21,22,24	7,21,2,3	—	meter	metre
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27	16	—	identifical	identical
32	1	—	Plate-7 A	Plate 6
41	11	—	Plate 1-5	Plates 7-11
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42-46	—	—	Plate nos. 4-7	Plate nos. 7-10
82	7	—	saey	safety
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96	12	—	Plate-8	Plate-12
97	—	13	Plates 9 & 10	Plates 13 & 14
98	—	—	Plate 12	Plate 13
100-101	Correction : Plate nos. 8-10 be replaced every where with 12, 13 & 14.			
114	5	—	Plate 8/6	Plate 12/6
116	15	—	Ineffective	delete
118	9	—	Plate 10/2-4	Plate 12/2-4
119	—	—	Plate no. 11/1	Plate 14
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